JOURNAL OF GAS LIGHTING & WATER SUPPLY.

EDITOR & PUBLISHER: WALTER KING. OFFICE: 11, BOLT COURT, FLEET ST., LONDON.

VOL. CXXII., No. 2615.] TUESDAY, JUNE 24, 1913. [65TH YEAR.

EDITORIAL NOTES.

The Institution Jubilee.

THE first part of the celebrations of the Jubilee of the Institution of Gas Engineers has come and gone; and the impressions that have accrued upon the minds of those who were present throughout the meetings, and participated in the events of the week, are many. The second part of the celebrations is to take the form of the great National Gas Exhibition in October next; and, concerning it, the best piece of intelligence of the week came from the lips of the President (Sir Corbet Woodall) when, at the memorable Jubilee Dinner, he announced, to the great satisfaction of those present, that Their Majesties the King and Queen have been graciously pleased to extend their patronage to the exhibition. The position, service, and efforts of the industry could not be crowned in better manner than by such recognition. Nothing is required now but the material support of those gas undertakings who have not yet placed their names upon the list of subscribers.

The exhibition is the next great event to which we have to look forward; the events of last week have present claim upon us. The combination of those events constitutes a magnificent success. Of this we are to-day positive, that the Jubilee of the Institution has given an opportunity for, and has resulted in, raising, in appropriate degree, the standing of the gas profession generally among the professions of the country. The channel by which this has been accomplished has been Sir Corbet Woodall; for his personal attractions—the unfailing courtesy, the dignity of his life and conscientiousness which has produced a universal confidence and respect, the high plane upon which he has ever placed the affairs (the large and small alike) of the industry with which he has grown in years, and for which he has laboured—brought about the Institution in the days of its jubilee celebrations a recognition from other British scientific bodies that could hardly have been hoped for in less influential circumstances. The contact and the intercourse with representatives of other professional and learned bodies will have a good lasting effect, if the gas profession sees to it that the good that has been done is not allowed to wear off, and ultimately vanish, by a relapse into the stereotyped and somewhat humdrum habits of the past. Another circumstance of the week has been the accentuating and strengthening of the bond of union between the British gas profession and our friends across the seas. From the Continent, from America, from remote Australia came the deputies of other gas organizations, bearing felicitations upon the Jubilee, and the greetings of professional brethren of several lands, while messages, composed of congratulation, appreciation of the work of the past, and the heartiest of wishes for the future, also came by cable from many sources.

We do not know of another industry that has less national frontier separating the professional workers than the gas industry. We have our national rivalries in the effort to be first to register advance in the several directions which the scope of the industry offers. *Vincit amor patriæ.* And professionally we would have it so; for it means, like the encouragement of individual enterprise and endeavour, greater progress. But the rivalry has about it all the elements of good sportsmanship, and the separation of self-interest from the aspirations to the greatest ultimate good from whatever quarter that which promotes it may come. We applaud our German, our French, our American, and our other friends on successes which infuse new life into the universal gas industry; they, in their turn, applaud us for our contributions. We hope it will ever be so; and it will ever be while such friendship as we have seen expressed, not only last week, but previously, prevails. The words of the venerated Dr. Hans Bunte, on behalf of the German Association, at the opening sitting, the eloquent expressions, on behalf of the Société Technique, of M. Ellissen (whose esteemed father was present at the birth of the British Association of Gas Managers) at the Jubilee Dinner, and the feeling that Heer Bolsius concentrated in his words on the same occasion on behalf of the Dutch Association, are the assurances of the perpetuation of our international amity, and of the best wishes of the gas profession of each nation that we shall all continue to work for the common prosperity of the industry. This being so, then we may believe with confidence that the hope contained in the closing words of the speech of Sir Corbet at the dinner, in replying to the toast of the "Institution of Gas Engineers," so well presented by Mr. Balfour Browne, K.C., will come to pass—that, "when by-and-by a gathering is held to com-
"memorate the Centenary of the Institution of Gas Engi-
"neers, I trust that it will be under circumstances as
"promising and as favourable as those under which we are
"met together this night." The present conditions of the industry—conditions economic, and all inclining to greater strength in service—supply a magnificent promise as to security in the time intervening, and as to the fulfilment of the aspiration.

We cannot compliment too greatly the President and the Council of the Institution upon the various incidents specially devised to mark the jubilee celebrations. There would have been still more satisfaction if the conveniences of Caxton Hall had been farther removed from the conveniences—and noise—of subterranean locomotion, as this marred good hearing. It was an eminently happy thought that gave birth to the presentation of his portrait in oils to the (in the world's gas industry) famed survivor of the band of men who founded the British Association of Gas Managers—Mr. Thomas Newbigging, D.Sc. The scene during the presentation and the acknowledgment by the worthy and venerable recipient of this mark of respect and affection will remain engraven upon the tablets of the memories of all present; while the act and testimonial—superscribing the verdict of "Well done" by professional colleagues from old to young—will be cherished by Mr. Newbigging in the time to come, which we hope will be long, in health and freedom from care. Much the same remarks apply to the conferment, on this occasion of jubilee, of the Birmingham Medal upon Sir Corbet. The Jubilee Dinner, too, was another memorable event, which, while symbolizing the extent of the area of the interests and concerns of the gas industry, produced abiding impressions, and a recognition of the standing and importance of the industry by other professions and by other industrial organizations. The garden party at Chislehurst, on the graceful invitation of the President and Lady Woodall, which was the closing event of the week, and at which farewell was to be made to Sir Corbet as the occupant of the presidential chair, but not as the professional leader whose influence and counsel will be, we hope, for many years at command, was a great success in point of numbers and environment, but the occasion was somewhat spoilt by intermittent rain. The best, however, was made of this elemental drawback; and good feeling and cheerfulness ruled in the large marquees during the periods of temporary retreat from the enjoyment of the lawns and enticing walks through the wooded acres. There was another event which we must not fail to notice, and that is the retirement of the Hon. Secretary (Mr. S. Y. Shoubridge), whose loyalty to the Institution and untiring efforts on its behalf are recognized throughout the membership; and the testimony of this has been duly recorded in a framed illuminated address. Mr. W. E. Price, who possesses just the indispensable qualifications for the attaching responsibility, succeeds to the office.

These and many other incidents go to fill the record of the historic occasion. Just as we have at the jubilee been looking back to the happenings at the foundation of the British Association of Gas Managers, so those who will arrange for the Centenary celebrations, fifty years hence, will look back to the records to ascertain how those respon-

sible ordered the proceedings at the Jubilee. Of what has been done, and is to be done, there is every reason for gratification, and nothing of which to be ashamed in the way of inappreciation of the claims of such a celebration. We go hence with the full conviction that the industry is, by current work, on the highway to a still greater wealth of prosperity, in which we and our successors will greatly rejoice. In the first year succeeding this epoch-making Jubilee, the presidential chair of the Institution will be occupied by Mr. Edward Allen; and the annual meeting in 1914 will be held in Liverpool, to which city the Chairman of the Liverpool Gas Company (Mr. H. Wade Deacon, J.P.) has, in the name of his colleagues, personally, and with marked cordiality, invited the members next June.

The Presidential Address.

THE spirit of the Jubilee was upon the President when he prepared, and when he delivered, his Inaugural Address. It was the expected deliverance. It was a deliverance as eloquent as it was steeped in cogent thought, and the broadest philosophy. The charm of the personality of the author was in and upon it in its every period; and the pulsations of his feelings and thoughts were communicated through it to his audience—in numbers, and in obvious intent interest, unrivalled. One can sympathize with the emotions of a man who, by the free and unanimous choice and action of those among whom he has spent his professional years, is called upon to preside over them on such an historic occasion as this; for he knows that he stands there by virtue of distinguished work, of pre-eminent position, and of a common affection and respect—work of a kind that cannot be done in few years and without special qualification, position that cannot be created but by many years, and affection and respect that time alone can spread to such extent as in this case. It is indeed something of which to be proud that "when well advanced in a long and busy "life," one should be adjudged by peers and colleagues, amid changed scenes and circumstance, to be the man to lead and to head.

The President has passed his jubilee in the service of the gas industry; and that means much indeed. It means among other things a mature experience, and in this case an experience so vast, under many conditions, that it is incomparable. The effect of passing time with some men—it is constantly seen in our daily walks, it has been observed in the gas industry, as in other industries—is a stunting of opinion and a shaping of decisions under contemporary circumstances by what has been done, and by what mayhap has been successful, in the past under other conditions. Not so with Sir Corbet. Those who know him well, those to whom the progress in professional and administrative life is an open book, have full cognizance of the fact that the ever-accruing experience has only formed for him fresh points from which to survey the conditions of the new day, and to shape his work and to act accordingly. There we have revealed, if revelation it be to any in the gas industry, the cause of the freshness, the buoyancy, and the power with which the new necessities and the new functions of changing time in this likewise changing industry of ours have been dealt with, and has set example, as is meet and right, from the very van of the industrial organism. This trait, this innate quality, that has made the professional and administrative life a success, permeates the presidential deliverance. There is nothing there of cramped view; there is nothing there that is impulsive, or written for the mere reward of transient applause. It is all deliberate, and full of thought; and it all points the way, as is its intention, to present and future stability, and to the maximum service within the limits of opportunity to the industry and to the community. In all these matters, there is an individual responsibility, and that responsibility served as one of the principal members in the structure of his Jubilee Address. Somewhere in it, the President reminds us that what we are to-day is due largely to what we ourselves have been, and have done, in the past. What the industry is to-day, is what it has been made by those who have worked in the years that are closed. What it will be in the future is largely what we who are working in the present make it; and our successors will bless or upbraid according to the light in which we hold our responsibilities, and comply with their claims and behests.

The line of thought that one can trace through the address, and its objects, are perhaps indifferently represented in what we have said. There was also thankfulness for what has been done in the past, and for the clear indications as to what should be done in the present, and strong hope for, and a fervent belief in, the future of the industry. In every part of Sir Corbet's limpid and robust utterances were such feelings as these seen. There was survey of the past; and, as befits an address at a jubilee-keeping, the President did not permit himself to stray far from the fifty years, though he fitly indulged in a passing reference to the centenary of statutorily controlled gas enterprise. In the survey of the past, there was just the touch given, which deepens and broadens interest, by the hand of the traveller who has personally journeyed through the years At the beginning of the organization celebrating its jubilee, the President was in the lines with, though not actually one of, the little band of men who, in Manchester in 1863, founded the British Association of Gas Managers, one of whom it was his honour and good fortune to be able to welcome to the meeting—Mr. Thomas Newbigging. Round that name (as around that of Sir George Livesey and the President) clusters much of our industrial history. The hopes and intentions of the founders were great, as formed amid an environment far different from that now existing. Nevertheless, at the jubilee of the organization which then had its genesis, the President is able to say conscientiously that it has abundantly fulfilled all in regard to it that laid in the hearts of the founders, and of those who became connected with it in the early days of its life, and of whom the President was one. A mistaken notion has a fairly rife existence that fifty years ago the conditions in the gas industry were of humdrum character. "It was a lively world into which "the British Association of Gas Managers was born," said Sir Corbet. That is very true. Those were the days when it was imperative that the feet of the industry should be placed on surer foundations than they had theretofore occupied; for up to then the conditions of its existence had been of a somewhat chaotic nature. There was thorny competition in those days; but the competition was internal, and not external as now. It had been considered an inviolable law that competition was the only way to keep down prices; but, as the President rightly says, that law, like all generalizations in political economy, is open to test by exceptions. Such exceptions are found in the supply in town districts of gas and water. Thus it was that, in the early days in the history of the Association, things in the industry began to emerge from the turmoil of the past on to settled ground, to the advantage of the public service.

The chord that hereabouts in the address was struck by the President must have gone home to every listener. It was in the graceful and noble tribute to that optimate in, and reformer of, the gas industry, Sir George Livesey, whose work gave new shape and course to the industry's fortunes and opportunities. "The name of Sir George," said the President, "can never be spoken without reverence "in such a meeting as this." Human heart cannot listen without some emotion to such words as fell from this life-long contemporary of Sir George, and such a contemporary as this one. "I desire to take this opportunity—and such "must be rare for me henceforward—to speak my deep "appreciation of him who made the greatest name in the "history of our industry while he was a member of this "body, for the devotion and understanding which he gave "to its protection and advancement." Point by point, we have the story told of the large part that was taken in the fifty years by Sir George in introducing into the industry organic reform, which smoothed its ways and operations by co-partnership first of supplier and consumer, and then of worker, that has been of incalculable worth to the industry. Truly spoke Sir Corbet, when he said that the fact that the national gas industry is so flourishing as it is to-day is due to Sir George Livesey more than to any other man. True Welsbach did his part in preserving the industry; but it was Sir George who did the greater thing in having, ten years before, initiated a new highway and conditions to prosperity for the industry. Other men are spoken of, and have their names inscribed in this Jubilee address, for services that are ancillary to those of Sir George. The natural developments during the past thirty years or so in the use of the industry's primary product, have all found that the presbytic work of the reformer and his colleagues had paved the way for their easy adoption.

The survey by the President, cursory but satisfactory as it necessarily is, of the technical developments of the industry covers much historic ground. In these technical develop-

ments British brains and hands have done much; and there is great indebtedness to the Continent and America for fundamental contributions to the developments. The work, however, of technical expansion is not completed, and it can never be, though the at-one-time faint lines of future progress become strengthened day by day. In the work already in hand, there are problems unsolved. We will only stay in this connection to emphasize one or two points. The President brings into relief the fact that the problem of thorough sulphur purification remains to be solved; and our friends the chemists must take to heart the reproach, good-naturedly uttered by him, that it is impossible to compliment chemical science on this desirable consummation. Work to this end, however, is proceeding in several directions—at the South Metropolitan Gas-Works, at Birmingham, at Cheltenham, and elsewhere; and it is naturally hoped that one and all will be crowned with success, for a commodity of the utmost possible purity, consistent with economy, is required of the industry. As the address is read, it is borne upon the mind how completely in every direction, though manufacturing principles have not changed, productive developments have correlation with the developments of use, which have unified the requirements in respect of a gaseous fuel in a common standard of quality—that of thermal value. Incidentally, Sir Corbet hopes gas undertakings will take early opportunity to get their standards of quality changed to the only rational one to-day. Everything has been shaping to the end of the production of the needed quality of gas, and especially in our carbonization processes. Still of these we have yet to learn more—among other matters, regarding the thermal behaviour of coal in the processes, the effect of radiant heat and hot surfaces on the distillation products, as well as the effect upon them of passing through incandescent coke. On these points the research to be conducted at the Leeds University may tell us more. But in connection with carbonization, we find the President warning off our low-temperature carbonization friends, who desire to thrust processes and opinions upon the gas industry that are inconsistent with its service, and to set at nought its solid experience and knowledge of requirement, gained through long years.

There is the part—and it is a great part—that the gas industry takes in the national economy, and the course of which it would be fatal to change at the beck and call of ultra-enthusiasts for smokeless fuel, or those who offer the gas industry a speculative market for motor spirit. The production of gas cannot be subordinated by the gas industry to anything else. Those, too, who propose concentration at the pit's mouth were subjected by the President to a little of that gentle ridicule, in which were flashes of humour, which is apt to cause, when it comes from the right place, those to whom it is directed to see their schemes visibly diminish in importance. Sir Corbet looked around with care. There came within sight the coke-oven and the gas-producer. But regarding circumspectly all schemes—existent and proposed—that offer to compete with, or to rival, town gas made under present processes, he arrives at the deliberate opinion that town gas is the only distributable fuel that is competent to provide, economically and efficiently, and from the one source, light, heat, and power. The use of coal by the industry is unmatched elsewhere for its richness of result. The industry is seen in a rejuvenated condition to-day; and, as pointing to this, and to the manifold uses of gas, there come from the lips of the President the simple but ringing words of true gas progressivism and enterprise: "Tell the people about it; let them have it at "the cheapest rates; and show them how to use it." There we have crystallized faith and precept.

The unswerving line of thought takes us to the outdoor department as created in response to current conditions; and, in its increased importance, we have the "greatest "modern change noticeable in the internal economy of gas "undertakings." But this department cannot compass its purpose unless its staff and manning are all educated in the technic of their work, and the capabilities of those things which are to serve, by good performance, both utility in the house of the consumer and the reputation and popularity of gas. The appliances at command have reached a high point of efficiency—a point that causes them to rank ahead of competitors; and they must be supplemented by efficiency in the outdoor staff. There is no question that the distribution and use of gas at high pressures—for lighting and industrial purposes—is *the* most distinguished advance of recent times. The figures given by Sir Corbet as to the total pecuniary result from four of the Gaslight Company's high-pressure installations are eloquent as to the co-operative outside lighting of business premises being a sound trading proposition; and those who cannot sell gas at as low a price as is done in London may have their attention emphatically directed to the dictum of the President that "the *higher* the price of gas, the stronger the case "for the use of increased pressure, which economizes in "gas consumption, while being more expensive in annual "and running costs." In the work of heating, it is in the conservation of the heat, and in the work of illumination in the development from the potential energy of the flame produced by the combustion of gas that we have to look for further advances over competitors, who, like the gas industry, are not going to remain steadfast upon, and content with, present efficiencies. But, mark this all workers at the problem of gas combustion! Sir Corbet is dissatisfied, and there is cause to be, with the position of the science of the phenomena of gas combustion at different velocities of flow, which is what is involved in the use of various heads of pressure; and he is surprised that this problem has not been worked out to a helpful theory such as a plain man can understand. Who will respond to the implied challenge in this criticism, and throw more light upon the physics of the question?

Unconsciously, one wanders, in dealing with these various subjects, among affairs that bear upon both the present and future fortunes of the industry; there being an unbroken continuity in the development of those things which promote a higher state. Co-partnership is one of them; and, despite all that has been written about it, we have in the address one of the most brilliant arguments condemning the old order of things for its deficiencies in the matter of the correlation of capital and labour, and laying bare the uneconomy, the disappointment, the lack of encouragement, the absence of interest that all rest in the mere wage system. And there is a perfect symmetry in the case that ends in co-partnership. But before the satisfactory results can be made universal—the President does not see why some way should not be discoverable to bring even municipal workers under such a beneficent scheme—there is much to be done, part of which is the cure of the opposition of socialists and trades unions of a certain obstructive type. But he is a sanguine one among co-partnership chieftains who says he has "hopes that even these opponents will "come round if we are careful to approach them by the "points where we are agreed." In this connection, one may, though not legitimately a part of the matter, refer to the position in the coal market, which is working to the injury of the whole country. It is a peculiarity of the coal situation that squabbling and discord between masters and miners have the almost inevitable result of producing dearer coal, which means higher dividends for the coal owners and higher wages for the miners, while all other sections of the community suffer. As to redress, the President fails to see that any is forthcoming until something is done somehow to separate the legitimate demands of capital and labour in the coal industry from dearness of the article. How? That is a difficult problem; and it is made the more difficult from the fact that it is a rank growth from conditions that transgress economic laws.

As to the future, the working organizations of the industry are showing excellent vigour, which it behoves the industry to sustain; the industry has allied itself to scientific research in connection with its own particular requirements; and the President finds that there is a great difference for the better in the personality of the industry, compared with an earlier day within his memory. The industry is better equipped for service than ever it was. It has to make the best use of all that lies at hand, and to develop further aids to material good. It is a robust faith that Sir Corbet possesses, which perception, foresight, and enterprise, with their resulting fruits, have strengthened, and which enables him to declare that, whatever the future may hold hidden from us, the industry will keep to its sound lines, and there is little risk of the money sunk in our undertakings becoming unremunerative within any stretch of futurity of which we need take heed. Over all are hope and confidence. The address—glancing backward, surveying the present, and giving a glimpse into the future—is an inspiring one; and, from this time of jubilee, the words of the President will spur on many among us to further activity and endeavour.

The Papers and Discussions.

The technical fare provided for the meeting was of excellent quality; but the discussions on certain of the papers were poor. Notwithstanding all that the Council had endeavoured to do to ensure that discussion of the papers should have a sufficiency of time, it proved ineffectual in the result. It would, however, be unreasonable to take this occasion as a fairly representative one of what would happen, by the aid of the scheme, under normal circumstances. The proceedings at the first sitting were of such unusual nature, and of such attractive interest, that it was impossible to enter upon the consideration of the papers until the second day; and then, in the result, the paper by Dr. Humphreys on "Depreciation—Estimated and Actual" had to be taken as read, though, had it been the good fortune of the members to have had Dr. Humphreys present, this would not have happened. To ease the time, too, Mr. S. B. Langlands kindly intimated his willingness to be content with having his paper on "Ventilation and Gas" placed upon the records of the meeting. This left five papers, of which abstracts (in certain cases, considerable portions) were read. There was not quite an equality of treatment by the authors in this regard. Then some of the discussions were good; others, lamentable failures. This was not so much the fault of the Council as of those—the pity of it!—who entered their names to take part in the discussions. Having done this, those gentlemen (unless there was unavoidable reason) ought to have made it a point of honour to support the President by fulfilling their engagements in this respect. The absence of registered speakers was particularly noticeable when the discussion was taken on the paper by Mr. E. W. Smith and Mr. C. M. Walter on "Gaseous Heating." There was good discussable topic in the paper, and an excellent opportunity was supplied by it to give expression to opinions upon the subject of calorific power, to which there had been important allusions both in the Presidential Address and in the speeches delivered by the President and Professor C. V. Boys at the Jubilee Dinner. However, the meeting has passed; and this matter of insufficient discussion on certain papers is the only one for regret.

The Birmingham Gas Committee must feel highly honoured at the amount of compliment paid them regarding the display of enthusiasm on the part of their technical staff in the matter of research to win improvement. There is no other gas undertaking in the whole kingdom that has in recent years supplied the gas industry with so much valuable technical information from individual work as Birmingham; and this says much for the character of the staff, and for the encouragement which the Gas Committee and General Manager (Mr. R. S. Hilton) give to the members of their staff. The three most important technical papers were on this occasion contributed by Birmingham men—by Mr. W. Chaney, on "Coke-Oven Carbonization," by Dr. W. B. Davidson on "Liquid Purification," and by Messrs. Smith and Walter on "Gaseous Heating." We cannot deal with these papers to the extent that they deserve. But in regard to the first two, there are certain points that should be particularly emphasized. In the first place, one cannot condemn the use of coke-ovens on the *primâ facie* direct results from them; the value of the results is more of an indirect nature. It may be laid down as an acceptable rule that, where there is a demand for metallurgical coke, and the coke is being brought by rail from outside sources, there the coke-oven has value for the gas undertaking. It is a sound economic principle that the nearer the points of absorption of the secondary products of gas manufacture are to the *locale* of production, the better. Gas must be produced, and it is being produced, in ever-increasing quantities. True, the increase has been largely met without a proportionate advance in the amount of coke, owing to the improvement in the production of gas per ton. By departing from the ordinary ways of gas making, the Birmingham Gas Department have put themselves into a position for filling the wants of the local market for metallurgical coke, and so to the extent that that market absorbs the oven coke, the supply of ordinary gas coke from the gas-works is lessened. To our mind, the proceeding, for such works and in such an area, is marked by the highest administrative acuity.

Another important point is the introduction for heating purposes, in connection with coke-ovens, of Mond gas-producer plant. This is a question about which the gas profession wants to know more from absolute experience. But if it be true that the ammonia recovered from these outside producers is sufficient—and the efficiency of the plant is high in this respect whether slack or coke is used in the producers—to pay for the capital and maintenance charges, and to reduce, by a substantial percentage, the ordinary costs of heating per ton of coal carbonized, then here we have an economic proposition that will not remain where it is left in Mr. Chaney's paper. One other point under this head. The author spoke of the effects of alkali salts upon the walls of the ovens; and, in the discussion, there were references to the effects upon retorts of introducing such salts into them for the purpose of improving the coke. We rather fancy there will be a reinvestigation of this matter after what was said--more particularly by Mr. Allen and Mr. Kendrick—at this meeting, because the shortening of the life of the retorts may not have its compensations in the improvement of the character of the coke. There is also the question of the higher heat-resisting qualities of retort material, raised upon the report of the Refractory Materials Committee, in relation to which Mr. E. Körting (who has recently been visiting America) brings back a remarkably good account from there of the employment of silica material, which allows of higher temperatures and quicker carbonization of coal in bulk, through the greater heat conductivity of the material, and its resistance to depreciation by the higher temperatures used under modern conditions.

The most important announcement that Dr. Davidson made in his paper is that in Birmingham they are confident of having recorded a success of the process of extracting sulphuretted hydrogen and carbonic acid from gas by means of a purified ammonia solution. If this has been accomplished, then Birmingham will deserve all the praise the industry can shower upon it. A fatal defect of precursors in this line has been the great loss of ammonia. But in the new process, Dr. Davidson has, in the operation of ammonia distillation, introduced a carefully regulated gradation of pressures in the still, in addition to the control of the temperatures; and he finds that this one improvement supplants failure by success. As he says, it is a wonder that previous experimenters have not hit upon this very obvious aid to the separation of the ammonia, sulphuretted hydrogen, and carbonic acid gases; pressure having a most important influence on the solution of all gases. Is the reproach in the Presidential Address as to gas chemists not having yet thoroughly solved the question of purification going to be removed by the production of a plant of comparatively low cost installation and operation at Birmingham? If this paper of Dr. Davidson is well studied, it will also result, wherever practicable, in the avoidance of single ascension-pipe working with horizontal retorts; for the mischief that the single ascension-pipe does in the formation of impurities is of a character that imposes additional work on the purifying plant.

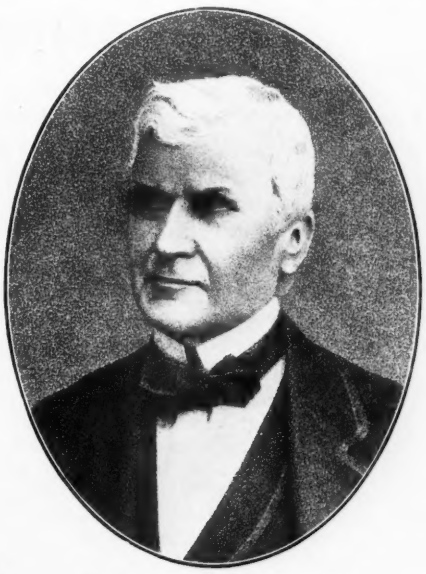
If we do not comment upon the paper by Messrs. Smith and Walter on "Gaseous Heating," upon that by Mr. F. W. Goodenough on "Creating an Outdoor Staff," and upon that by Mr. A. A. Johnston on "Suburban Gas "Supply," it is from no inappreciation of their value, but because of the mass of material with which we have to deal this week. No one will think of entering upon the industrial gaseous heating business without reading the informative first-named paper, which gives encouragement to the cultivation of this branch of trading. Those responsible for the commercial conduct of gas undertakings cannot afford to neglect to study Mr. Goodenough's valuable contribution, to learn how the Gaslight and Coke Company educate their men and boys; and the managers of small undertakings will note the suggestion as to co-operation among themselves, and with the local educational authorities, in this publicly (as well as industrially) beneficial work. The argument for a liberal attention to the distribution system through rearrangements, enlargements, and the application of high pressures that is found in Mr. Johnston's paper will be of value for its suggestive character.

The Late Mr. Arthur Graham.

At Friday's meeting of the Mansfield Town Council, a sympathetic allusion was made by the Chairman of the Gas Committee (Mr. T. Smith) to the death of Mr. Arthur Graham, for many years the Gas and Water Engineer to the Corporation; and, upon his proposal, it was decided to forward a letter of condolence to the family.

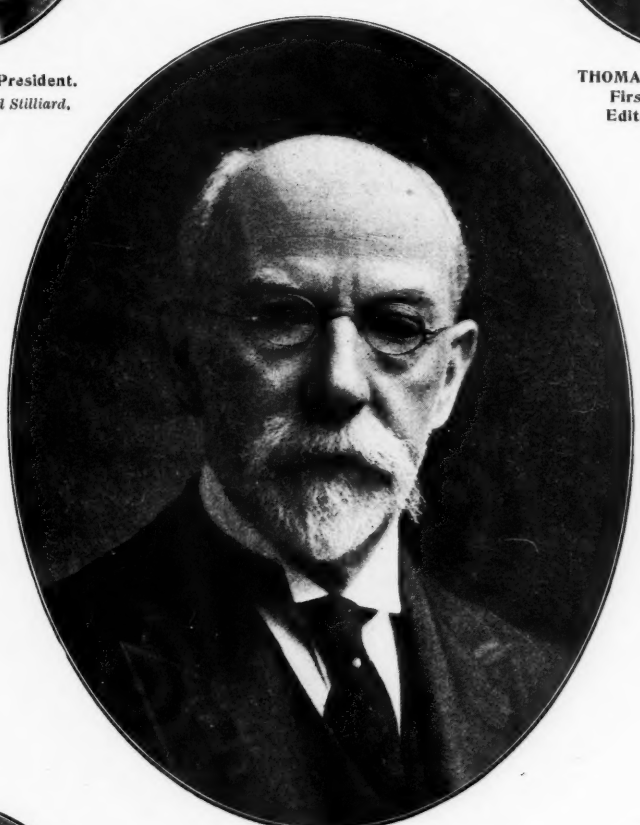
PAST AND PRESENT.

THOMAS HAWKSLEY—First President.
Photographed, in 1886, by Adams and Stilliard.



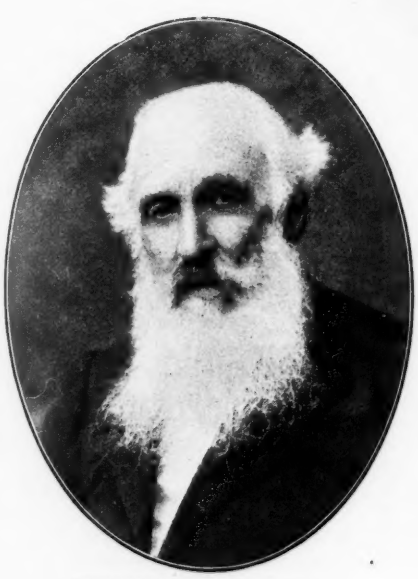
THOMAS GREAVES BARLOW—
First Vice-President and
Editor of the "Journal."

1863.



SIR CORBET WOODALL,
D.Sc., M.Inst.C.E.
Photographed by Elliott and Fry.

1913.



THOMAS NEWBIGGING, D.Sc.,
M.Inst.C.E.
An Original Member.
Photographed by C. Ireland.

EDWARD ALLEN, of Liverpool.
Jubilee Senior Vice-President.
Photographed by Walter Scott.

THE FOUNDATION IN THE YEARS 1863 AND 1864.

As a prelude to the Review of the Proceedings at the Jubilee Meeting of the Institution of Gas Engineers, let us glance back to the years 1863 and 1864, and briefly trace the proceedings associated with the origin of the central technical organization of the British gas industry—not the first gas organization, for prior to this a closer companionship and mutual intercourse among Scottish gas managers had been effected by the establishment of an Association. Therefore the central organization cannot by rights be called the parent association of the gas industry.

Following one of the early Scottish meetings, a letter appeared in the "JOURNAL" for Aug. 25, 1863, signed by "W. J. W," which initials, we may safely assume, fix the authorship of that letter upon the late Mr. W. J. Warner. Often in his day Mr. Warner was heard to proudly boast that he was the real originator, if not one of the actual founders, of the British Association of Gas Managers. In the letter in the age-soiled volume before us, "W. J. W." refers to the meetings of Scottish Gas Managers, and then proceeds to make certain remarks in the hope that "a kindred Association may arise among ourselves." He called attention to the fact that the chemical and engineering professions had their associations—indeed, the latter had no less than three: The civil, mechanical, and foremen's. The kernel of the letter is found in these passages:

> "In some of these, and in the Society of Arts, British Association, Geological, and kindred societies, most of our leading men, I believe, are to be found. Indeed, their support was given but a few years ago to a gas-fitting association—thus evidencing that, if a proper position be taken, and not too much attempted, or expected, a *British Association of Gas Engineers* will not lack supporters. The failure of the gas-fitters' association, though well started and supported at the commencement by able lecturers, was from its attempting too much—it died from exhaustion."

Then "W. J. W." proceeded to say that what appeared to him to be mostly urgently wanted was a general meeting of gas men once a year at which the leading subjects of interest to the "gas trade" might be discussed—not by set orations, but in a simple, business-like manner, and that any new discovery, invention, or patent might have publicity given to it, with the advantage of seeing it in operation. That would have been rather a tall order as things have developed. In the then opinion of "W. J. W.," two days would suffice for the meeting, as well as for the renewal of old personal friendships, and the formation of new ones. At the meetings, he also thought that a general exhibition might be held, that would have had a mixed engineering, floricultural, and horticultural aspect. In the composition of the exhibition, he suggested the incorporation of plans, models, apparatus, and fittings, as well as fruits, flowers, &c., grown in and near gas-works, with or without manures from residual products, and other applications of these products. The Finance Committee of the Institution might observe that, in the opinion of our correspondent of fifty years ago, "the business of such a society could, comparatively, be easily and inexpensively transacted." It was suggested, in order that a practical turn should be given at once to the proposal, that the names of those willing to co-operate in the formation of such an Association should be forwarded to the Editor of the "JOURNAL."

Though "W. J. W." does not appear to have taken part in the initial meetings inaugurating the British Association of Gas Managers, there is no question that his letter was the birth of the idea, and that to expand it, some activity proceeded, in an unobtrusive fashion, between August and December, 1863. There is sufficient evidence of this in a letter forwarded to us in December, 1863, by Mr. James Blackburn, who acted as Hon. Secretary at the time of the foundation of the Association. This communication covered a report of the preliminary meeting of gas managers held at the Royal Hotel, Manchester, for, as Mr. Blackburn said, "the purpose of considering the proposal contained in a recent number of your valuable 'JOURNAL' for forming a British Association of Gas Managers;" and at the same time our correspondent solicited our "cordial co-operation and influence on behalf of the Association." The preliminary meeting referred to was held on the 15th of the month last mentioned; and the records of the proceedings at that and many succeeding meetings are only to be found in our pages, or in the reprints from our pages of the reports, and which reprints (bound in the well-known green cloth cases) have during the half century formed the official record of the proceedings of the central organization.

Turning to the report of this preliminary meeting ten days before the Christmas of 1863—it was a Tuesday, and Tuesday is the favoured day for the opening of the annual sittings of the Institution—it is seen that "the following gentlemen, being engineers or managers of gas-works were present:"

Mr. Adamson, Leeds.
" Paterson, Warrington.
" Dyer, Burton-on-Trent.
" Fraser, Loughborough.
" Leather, Burnley.
" Wood, Bury.
" Hutchinson, Barnsley.
" Cathels, Shrewsbury.
" Blackburn, Droylsden.
" Martin, Ormskirk.
" Forsyth, Sowerby Bridge.
" Broadhead, Grimsby.
Mr. Simpson, Rugby.
" Fingland, Todmorden.
" Whitaker, Brighouse.
" Larkum, Ripon.
" Cleland, Liverpool.
" Brandwood, Radcliffe.
" Green, Heckmondwike.
" Rowe, Wrexham.
" Newbigging, Bacup.
" Dand, Buxton.
" Hall, L. & N. W. R. Coy.
" Owst-Atkinson (Lessee).

It will be noticed that among those actually present at the foundation meeting was Mr. Thomas Newbigging; and he appears to be the only survivor among the band of men who can claim that distinction to-day. In correspondence that appeared in our columns last year, Mr. Henry Woodall, relying upon his memory and incidents of the time, stated that there was a meeting prior to the one at which the Association was established at which he was present.

True there are others with us to-day who can claim the distinction of having signified their adherence to the scheme for the formation of a central organization for the gas profession, and who were among the original members of the old Association. In the same report, we see that several of the men of the industry at that day wrote expressing regret at their inability to be present, but testifying their approbation of the objects of the meeting. The published list of these is as follows:

Mr. Green, Preston.
" Woodall, H., Longton.
" Esson, Cheltenham.
" Brown, Arbroath.
" Hislop, Ayr.
" Helps, Bath.
" Goddard, Ipswich.
" Fleming, Lancaster.
" Wilton, Halifax.
" Murdoch, Maryport.
" Watson, Falkirk.
" Graves, Stockton-on-Tees.
" Young, Stoke-on-Trent.
" Reid, Edinburgh.
" Leslie, Aberdeen.
" Wright, Shipley.
" Varley, Colne.
" Shaul, Penrith.
" Adamson, Galashiels.
" Young, Dalkeith.
" Hogg, Melrose.
" Blackburn, Hebden Bridge.
" Methven, Bury St. Edmunds.
Mr. Kay, Dundee.
" Oastler, Worcester.
" Bowen, Cardiff.
" Morton, Woolwich.
" Cowan, Chester.
" Lawson, Knottingley.
" Stout, Boston.
" Tallentine, Whitehaven.
" Lawton, Newcastle-under-Lyme.
" Church, Huntingdon.
" Cotton, Warwick.
" MacPherson, Gloucester.
" Craven, Keighley.
" Dunning, Middlesbrough.
" Proctor, Forfar.
" Copland, jun., Hull.
" Glynn, Chepstow.
" Richardson, Carlisle.
" Whitecrop, Dumbarton.
" Roberts, Holyhead.
" Bean, Bradford.
" Church, Chelmsford.
" Bryan, Newport.
" Akroyd, Gomersal.

Few of those who figure in these lists are with us to-day but many a cognomen appears that is represented to-day by sons—some whose hair has grown grey through years—who are esteemed highly in the industry, and who hold distinguished position in it. In 1865 Mr. (now Sir) Corbet Woodall, who was then at Stockton-on-Tees, was elected a member; and Mr. (afterwards Sir) George Livesey's name first appears in the published "Transactions" for 1866. It is interesting to look down the early lists of members to see the many names included in them that have been as household words among gas men—names of men whose memories are revered, men whose work has been continued close up to these times, men whose work is still

being continued, men whose work guided to tracks and to policy that have led to great industrial fortune.

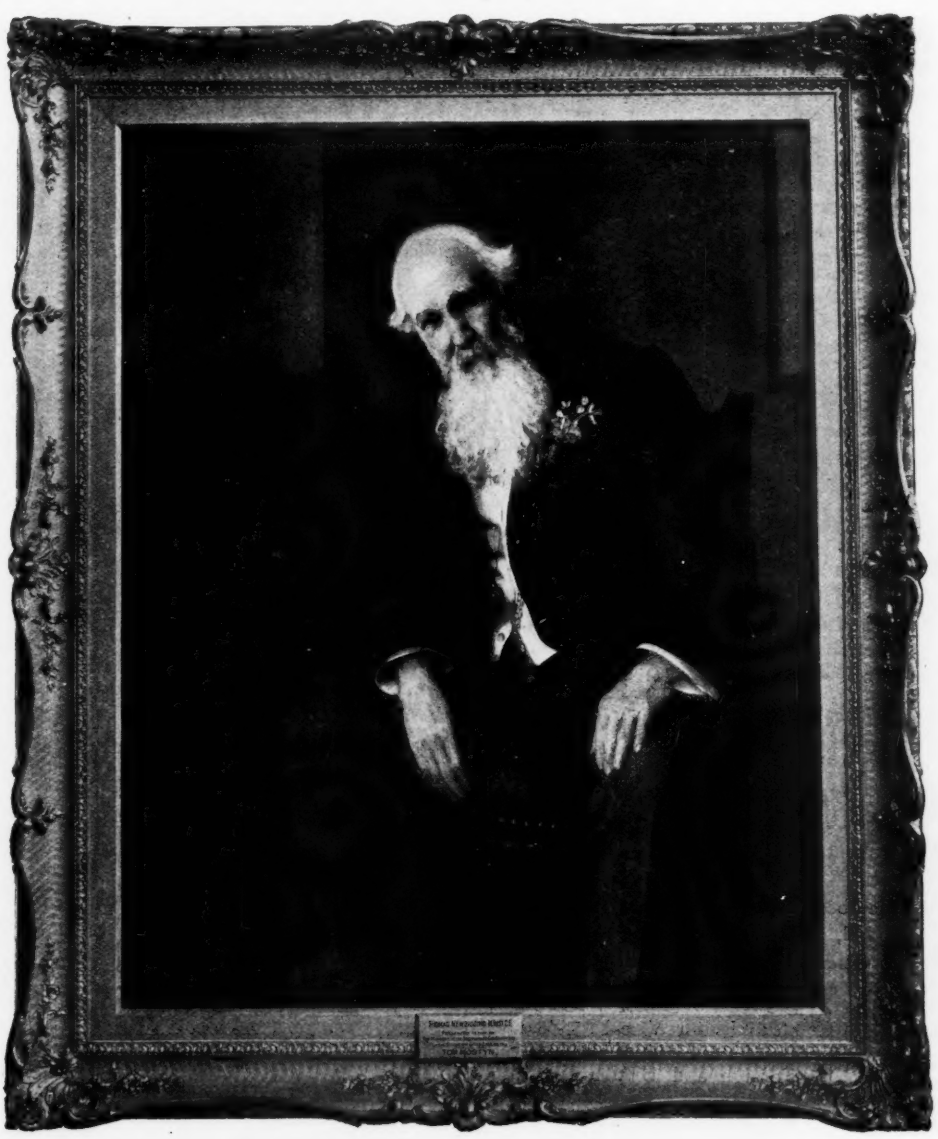
Mr. Adamson took the chair at the meeting on Dec. 15, 1863; and he did so on the motion of Mr. S. P. Leather, of Burnley, seconded by Mr. Forsyth, of Sowerby Bridge. In Mr. Adamson's remarks, he pointed to the value of opportunities for intercourse; and he predicted that the result of association would be the further development of all matters connected with the manufacture of gas. It was on the proposition of Mr. A. C. Fraser, of Loughborough, seconded by Mr. Dyer, of Burton, that it was unanimously decided:

> That it is desirable to form an association for the encouragement and advancement of all matters connected with the manufacture of gas, and that such an association be now formed, and called "The British Association of Gas Managers."

The remainder of the meeting was spent in discussing the regulations.

The first general meeting was held at the Mechanics' Hall, Manchester, on May 11, 1864; and at that meeting Mr. Thomas Hawksley was elected as the first President of the Association; and Mr. Thomas Greaves Barlow, Vice-President. Mr. Barlow was at the time the Editor of the "JOURNAL," in the management of which he was associated with Mr. William Broughton King, the father of the present Editor and Publisher. It is interesting now to recall that the connection with the "JOURNAL" of Mr. W. B. King commenced in 1856; and he became Editor in 1872. From the first meeting of the British Association of Gas Managers to the one in the year preceding his death, which occurred in 1878, Mr. King reported and prepared the published proceedings.

These particulars are interesting at the time of the Jubilee meeting of the Institution. At the first meeting, after his election as President, Mr. Hawksley, referring to the new organization, remarked: "I trust that we shall see it flourish and increase, and that the benefits which it proposes will be very largely realized." Fifty years after those words were uttered, it can be claimed that the hope has been fully realized. In connection with the organization, there have been days of storm. But they have passed; and the calm has succeeded. There have been times when lethargy has been all too pronounced. Those days, too, have passed; and the Institution has entered into a wider sphere of work and usefulness which will add—if the work be prosecuted with energy and vigour, and with an eye wide open to requirements as they unfold themselves—more laurels to an honourable history founded mainly upon the technical development of the gas industry.



PHOTOGRAPH OF THE OIL PAINTING

PRESENTED TO MR. THOMAS NEWBIGGING, D.Sc.

Artist—Mr. Tom Mostyn.

THE JUBILEE MEETING

OF THE

INSTITUTION OF GAS ENGINEERS.

PROCEEDINGS AT THE MEETING,

HELD AT THE

CAXTON HALL, WESTMINSTER.

JUNE 17, 18, and 19, 1913.

President: SIR CORBET WOODALL, D.Sc., M.Inst.C.E.

REVIEW OF PROCEEDINGS.

(For Full Report see page 923.)

THE long-talked-of day arrived—the first day of the Jubilee Meeting of the Institution. Old Sol, on the morning of Tuesday, pronounced a glorious benediction upon the industry whose foundations he helped to lay in the ages long ago; and the radiance he spread around helped to make still more light of heart those who were assembling for this very special occasion for the professional section of the British gas industry. Perhaps if his good intentions had been expressed with a few degrees less intensity, there would have been equal thankfulness to him for his excellent part. But we must not grumble; for the brilliance was of good omen, and befitting an industry that is hopeful of long continuing its brilliant way. As one walked along Victoria Street between ten and half-past ten, and through the by-ways leading to Caxton Hall, where the meeting was to be held, one recognized friends in and of the industry from all quarters, all making for the same objective. Here from the North, there from the South, and again from East and West. In the little thoroughfare on to which Caxton Hall opens its main doors were encountered the veteran Dr. Hans Bunte, Mr. E. Körting, and quite an imposing contingent from Germany, Belgium, and Holland. Groups of gas men and several ladies were there, greeting each other with the enthusiasm that comes from periodic absence one from the other. Passing into the hall, there among many others was encountered Mr. Thomas Newbigging, D.Sc., bearing his weight of years bravely, and recording his presence on this occasion of jubilee by signing the register of attendance. In the large hall well before the time fixed for the meeting, there was a considerable gathering; and when the clock marked the half hour—so rapid was the incoming—the lower part of the hall was filled. Late comers searched for seats in the body of the hall. Those who could not find that for which they were in search, had to betake themselves to the gallery, where there had already assembled a goodly contingent of ladies, as is the custom on the opening morning of the annual meeting; but during the more prosaic proceedings on the two following days, they are elsewhere. The impression is that never before has there been, in numbers, such a meeting of the components of the Institution as on this occasion; and very rightly, being the celebration of the Jubilee.

The Front Rows and the International Platform.

In the front rows of chairs in the body of the hall sat the members of the Council; and among them were three ordinary members who can claim to have been present at more annual meetings of the central organization than the majority of the members. These were Mr. Henry E. Jones, Mr. Henry Woodall, and Mr. W. R. Cooper. Elsewhere was also seen the venerable Mr. G. R. Hislop. There was also the Hon. Secretary designate (Mr. W. E. Price). But the platform is filling. We see the Senior Vice-President (Mr. Edward Allen) and the Junior Vice-President (Mr. John Bond). There is the ex-President of the Institution (Mr. R. G. Shadbolt). Foreign and British Institutions are represented there. The meeting rejoiced because they were there to participate in the celebration. We may not have secured all the names of those who had journeyed over the seas to be present. From America, there were Dr. A. H. Elliott, Mr. Morris W. Stroud, and Mr. A. B. Searle. Despite the attractions of the meeting at Toulouse of the Société Technique, M. Ellissen had loyally obeyed the request of the President of the Société that he should convey in person the felicitations of the members to their British *confrères* on this notable occasion. From Germany, prominent was our friend, learned in gas science, Dr. Hans Bunte, whose name is known throughout the world's gas industry. Mr. Ernest Körting had travelled from Berlin, smiling and bonhomie as ever; and Dr. Bueb completed the triple representation of the German industry. Little Holland was a good first in numbers. There was the President of the Dutch Association (Heer P. Bolsius), and the Vice-President (Heer O. S. Knottnerus), and the Hon. Secretary (Heer W. K. N. Geerling), together with Dr. L. J. Terneden, Heer L. Sauter, and Heer D. Bisschop. Always welcome was Mr. A. F. P. Hayman, representing the Belgian Association. Farthest traveller of all was Mr. S. E. Figgis, of Ballarat, joining, on behalf of the Victorian (Australia) Gas Managers' Association, in the celebration by the gas men of the Mother Country. Coming to the British Associations, the President of the Iron and Steel Institute (Mr. Arthur Cooper) was represented by Professor W. A. Bone, F.R.S., and the Society of Chemical Industry by Dr. Messel. Professor Harold B. Dixon, the President of the Society of British Gas Industries, was unable to be in London for the opening meeting; but he had a good

deputy in Mr. W. D. Helps; and we also saw a Past-President of the Society there, Professor Arthur Smithells, who is always *persona grata* among gas men. The British Commercial Gas Association was represented by Bailie Paxton, of Glasgow.

Welcome.

Punctuality is a trait of Sir Corbet Woodall; and as half past ten struck, he, accompanied by the retiring Hon. Secretary (Mr. S. Y. Shoubridge) and the Secretary (Mr. Walter T. Dunn), ascended the platform. The applause from the dense audience was spontaneous, and was continued until Sir Corbet seated himself, with at his right-hand side, Mr. Newbigging, Dr. Hans Bunte, M. Ellissen, and Mr. Körting, and to his left Dr. Elliott and Mr. Figgis. There were two items of formal business—the passing of the minutes and the appointment of two scrutineers (Mr. J. H. Brearley and Mr. Herbert Lees)—and then the President was on his feet welcoming, in choice phrase, the eloquence of which was as great in the expression as in the actual words employed, the distinguished visitors who had travelled from near and far to take part in the rejoicings of the members. Hearty greetings were more especially accorded to the visitors from abroad. The extreme goodness of them all was acknowledged. As the individual names were mentioned with a graceful compliment attached, there was applause. M. Ellissen's kindness in foregoing the pleasure of being present at the annual meeting of the French Société especially appealed to the members. When, too, the name of Dr. Hans Bunte was mentioned, it was acclaimed with great cordiality, for, to the holder of such a record as his, we could not, as Sir Corbet remarked, express in words any exaggeration of the satisfaction felt in seeing him present. His age was no bar to taking advantage of this special opportunity of being among his British friends. As a matter of fact, Dr. Bunte carries his years well; for he does not appear to be a year older than when one saw him at the International Gas Congress in Paris in 1900, and since on other occasions in Germany. His seniority and eminent standing very properly led to him being named to reply to the welcome on behalf of the foreign visitors; and this he did, in his native tongue, with a vivacity and earnestness that even those who did not understand the German language were able to fully appreciate. Mr. Körting kindly enlightened those who had failed to follow the Doctor. And they cheered the easily confirmed claim that the German Association had its advent some six years before the British organization. He also mentioned the delight that the visit of members of the Institution to Germany gave to the members of the German Association a few years ago; and of the further delight which they had since then experienced from the hospitality of their British colleagues. The Institution, the German Association, and all their cognates have one common aim, and that is to further the culture of the science of the gas industry; and to that end Dr. Bunte hopes we shall ever work shoulder to shoulder. The aspiration fell on responsive ears. Dr. Messel also replied on behalf of British scientific societies. The members were not a whit the less enthusiastic in their greeting of Dr. Messel, when they learned from him and the President (whose eyes were merrily twinkling as he spoke) that their guest had part and lot in the recent fight of the chemical manufacturers against the gas industry. The fight was a straightforward one, observed Sir Corbet, and nobody will be any the worse for it. The hatchet is buried.

The Living Founder.

Happy as were the incidents (and this first sitting was full of them) of this Jubilee Meeting, there was not one that was happier than the next. This was the presentation of his portrait in oils to Mr. Newbigging—the only survivor of that little band of men who met in Manchester in December, 1863, and there and then brought into existence the British Association of Gas Managers. There was hearty endorsement of the President's opening remarks when he claimed that there could not be a more appropriate incident in the Jubilee celebrations than this one. We were by him taken back in thought to the birth of the Association, and were told of the part that Mr. Newbigging had in it. "The child of his begetting has grown to healthy manhood" was one of many gems in a speech in which the President was at his best. And again, "we are glad to have him here to rejoice with us in its mature strength." There was compliment, too, over the interest displayed by Mr. Newbigging, in the days of his leisure, in the work of the younger men of the gas profession, to whom he has given, through his literary work, from the full store-house of his knowledge. Much else that fully expressed the feelings of those present found apt words, including the devotion to the recipient of his friends in the industry. The portrait, as Sir Corbet says, is an admirable one; and it is hoped the days may be many on which Mr. Newbigging will find it bringing to him happy memories of his numerous old friends.

Mr. Newbigging was on his feet—a striking figure on the high platform. With him rose every man in that vast audience; and never, the assertion may be ventured, has Caxton Hall rang with more hearty cheering. The audience resumed their seats. The venerable figure—bent at shoulder, with grey and patriarchal beard, but face radiant with pleasure—was for the time being the cynosure of the platform. The voice at first was barely heard; but only for the space of the first few minutes while there was reference to the kindly words that had fallen from the President. One of the heaviest burdens a man could have to bear was, remarked Mr. Newbigging, to have to listen to such sentiments—whether deserved or not. The well-known voice, heard at many meetings in days past, gathered strength. There was reminiscence; and there was dead silence as allusion was made by the speaker to himself as being the only one left of that small group of men who sat round a table in the Royal Hotel, Manchester, in December, 1863. To be the last living one is a gift of fortune. "But I can claim scarcely any credit for this, unless it be that I have husbanded my health [there was pause here]—by working hard." Whereat there was renewed cheering; for there was in the words the reflection of the wit that often interspersed speech in former days. Claim was made to being a link between the past fifty years, and the future years of the Institution. Mr. Newbigging is something more; he is a link between the years that preceded the foundation of the organization and the years succeeding this time of Jubilee. There was sparkle in eye, no tremor of voice, but the old manner in which one was wont to hear the same voice getting a point home in the Parliamentary Committee rooms, when he said: "I was an engineer before one-half of those present were born." But, in order to share with them the compensations of life, there were the words: "You have the better of me in the long-run. You will be at work when I am gone." When he came to refer to the portrait, and had acknowledged the excellence of the work of his friend the artist—Mr. Tom Mostyn—Mr. Newbigging hinted that he had wondered as to the worthiness of the recipient. But the emphatic "No" from the audience left him nothing to do but to bow to the superior judgment of the majority; and so he accepted the portrait as one of the greatest honours that have fallen upon him during his long lifetime. Following this and the further applause came an announcement from Mr. Shoubridge that Mr. Newbigging had handed him a cheque for fifty guineas, as a donation to the Benevolent Fund, to signify his appreciation of the high honour conferred upon him in the matter of the portrait.

Congratulations.

Quite a number of messages of congratulation were read by the Hon. Secretary, in connection with the Jubilee, from various Associations and well wishers.

The Birmingham Medal.

This was fittingly an occasion of extraordinary recognition of work well and truly done. Honours have been showering lately upon the President. There was the honour of knighthood by His Majesty; the conferment of the degree of Doctor of Science by the Leeds University; there was the unanimous selection by the Institution of Sir Corbet as the Jubilee President; and now came, without a dissentient voice, his selection for the addition of his name to the roll of distinguished ones who have had conferred upon them the Birmingham Medal. The honour of being the mouthpiece of the Institution in bestowing the medal upon the President fell to the Senior Vice-President, Mr. Edward Allen; and he discharged the duty in a manner that was in full consonance with the feelings of the members. The history of the Birmingham Medal was traced from its origin to the line of workers in or for the industry on whom it has been previously conferred. When Mr. Allen came to the

narration of professional merit, administrative ability, fame throughout the industry, and the high standard of personal character and professional conduct, that stand out as the salient characteristics of Sir Corbet's career, the emphasis of applause as each point was made left no doubt as to the honour meeting with the unanimous approbation of the profession. And Sir Corbet, in feelingly saying how very proud he was of the medal, and of being added to the roll of former recipients, did not attempt to justify the choice of the members. But his title is nowhere questioned. In a few simple words that he used, there is the essence of a career: "One claim I can put forward—through my life I have been concerned for the interests of our industry, and for the honour of our profession; and I have tried, within the limits of my capacity, to forward both."

The Retiring Hon. Secretary.

The Institution are incurring the loss of a devoted Hon. Secretary—Mr. S. Y. Shoubridge—who feels that the time he is now in the position to give to the duties of the office is inadequate. It was the President's next duty to refer to this severance of an honorary official tie, and to present to Mr. Shoubridge an illuminated address in which the Council recorded—and it is well merited—the high appreciation of the Institution of the valuable services he has rendered during the six years he has occupied the office, as well as his unfailing courtesy. There was also the heartiest expression of gratitude for it all. The President's words, in making the presentation, were warmly emphasized by the members. In happy manner, Mr. Shoubridge tried "to turn the tables" on those who thanked him by remarking that he thought his thanks were due to the Institution for having given him the pleasure of occupying the office. There was no question as to the sincerity of his words when he said he relinquished the office with considerable regret. There was acknowledgment as to how his work had been lightened and made easy by the indefatigable and courteous manner in which the Secretary (Mr. Dunn) discharged his duties. There was one satisfaction in resigning the office; and it was, he said, that his successor was to be Mr. W. E. Price.

The Education of Gas-Fitters.

The awards of medals for papers read at last year's meeting were next made; and then we came to the report and accounts. There were two main questions raised upon the report. One was on the subject of the examination of gas-fitters. The scheme that had been accepted, it will be remembered, was opposed to gas-fitters being subjected to a written examination. But the City and Guilds of London Institute made it a *sine quâ non* to their taking part in the scheme that there should be a simple form of examination; and as there was no option but to dissociate the work from the City and Guilds Institute, or to accept the examination, the Council recommended the adoption of the latter course. There was a sharp division of opinion on the point among those who spoke; but though this was so, there was a distinct desire that it should be known that no discourtesy whatever was intended to Sir Philip Magnus. We will not traverse here, except lightly, the points raised. The matter was introduced by Mr. George Helps; but the lead in the opposition was taken by Mr. James Paterson, who considers the external written examination a distinct departure from the scheme, and he thinks it will be distasteful to the trade organizations, and will militate against the efficacy of the educational project. He moved the non-adoption of the recommendation; and Mr. H. C. Head was a hearty seconder. Mr. Henry E. Jones tried to throw oil on the threatened troubled waters, by suggesting that, instead of moving the rejection of the recommendation, the Council should be asked to reconsider the question. He has a direct manner in conveying his points, as illustrated by his remark that his experience in this matter is that there can be too much paper, and too little of the hammer and chisel. Mr. E. H. Hudson made a telling speech in support of the Council's recommendation. The examination, he says, is to be a practical one, supplemented by an easy written examination. If there is to be a proper value attached to the work, it can only be by having the countenance of one of the recognized educational authorities of the country. It was an excellent phrase that concluded his remarks: The man who will not accept what he can get because he wants more, is an enemy to progress. Support to the Council was also given by Mr. H. Kendrick; and Mr. A. E. Mottram also made an apt contribution. A strong point was introduced by Mr. Walter Hole, the Examiner in Gas Supply, when he said that of the 400 or so candidates in the last gas-supply examination, quite half were from the ranks of gas-fitters. This being so, he feels that for a simpler examination a larger number of fitters will sit, in order to obtain a certificate. The President's experience of the examinations of the Gaslight and Coke Company is that a short written examination paper is not a tax on the men. Then Mr. Paterson altered his amendment as suggested by Mr. Jones; but, on a vote, the recommendation of the Council was adopted by a substantial majority.

A Home for the Institution.

There was also, upon the report, some discussion as to the question of a home for the Institution and kindred bodies. No one questions that such a place—from the points of view of convenience and distinction—would be an excellent thing; but the matter of finance is an important one, not only, as the President puts it, in regard to the purchase of a site and the erection of suitable buildings, but in respect of the annual expenditure. If ever there is a fair prospect for a scheme, the President will, while he can bring influence to bear, do his part in assisting to its consummation. But the time is not, in his or the Council's view, opportune. The question was raised by Mr. E. A. Harman; and he earnestly presented the case, suggesting that this period of jubilee is a favourable one for starting a fund for the purpose of ultimately erecting a building as a central place for the organized work of the gas industry. He suggested that the matter should be referred to the Council for further consideration. This Mr. H. E. Jones seconded; and after a little discussion, it was carried.

A United Industrial Organization.

Another matter which got somewhat mixed up with the foregoing was that of strengthening the power of the industry by uniting the various bodies engaged in its work. The subject was touched upon by Mr. George Helps; but an eloquent and really forcible appeal was made by Mr. J. C. Belton, his argument resolving itself into a desire to see the three principal organized bodies united into one, so as to give greater effective strength in the work that lies before the industry. A united Institution also appeals to Mr. Isaac Carr. But the President, it is clear, is not quite sure that a greater effectiveness can be obtained than is realized under the present order of things; and he strongly advised that the suggestion that the Council of the Institution should be asked to further consider the matter should not be persisted in at this time. Upon this, Mr. Belton allowed the matter to drop "for the present;" but he took occasion to allude to it again later on, as there appeared to have been some misapprehension as to his meaning. It seems that he was not suggesting amalgamation into one body, with everything in common, but rather a uniting into a body composed of sections. It is well, perhaps, the explanation was made, as there is a distinct difference of view on the subject existing in the gas profession.

Waterway Developments.

The variegated character of the proceedings at the sitting was added to by the passing of a resolution, urging the Government, in view of the facilities afforded to trade by the canal developments in Germany, France, and Belgium, the congested conditions and costs of railway transit at home, and the consequent hindrance to trade, to take immediate action upon the recommendations of the Royal Commission on Canals, by introducing a Bill to carry out the recommendation as to the appointment of a Waterways Board, and the acquisition by the State of the four trunk or main canal routes.

The Presidential Address.

The time allocated to the sitting had well advanced. The audience, however, maintained its solid character; but the heavy amount of work that had been transacted had had its bearing upon the freshness with which Sir Corbet had approached his presidential duties earlier in the

morning. To deliver an address—and such an address as was expected on this occasion—after an exhausting amount of business for the one primarily responsible, must have been a great task. But the President faced it; and, though here and there he curtailed the prepared deliverance, there was nothing lost of the thread of what he wished to convey. The vast audience was held by his words; and as he again journeyed through the avenues of the past, those present punctuated with applause the many points that appealed to them. The references to the founders of the British Association of Gas Managers, and the men who nurtured the new organization, found their way to gratified ears; and there was also intent interest as the President gathered together from the mass of incident in connection with the development of the industry, those events that had particularly contributed to it. The allusion—apposite, incontrovertible, and genuinely heartfelt—to the work of Sir George Livesey evoked the greatest endorsement; and the recognition of the services of Mr. Charles Carpenter was also greatly appreciated by the members. The text of the address was published in our columns last week; and there is an article upon it in earlier columns. The historical area that it covered was considerable; but it justified all the time bestowed upon it both before and at the meeting, as well as the careful examination of its contents that one is compelled to make when once begun. Its parts are all good. But those present at its delivery especially liked the one in which was unerringly pointed out the great place occupied by the gas industry in the national economy. We all individually like to be patted on the back; and when the patting is applied to the collective industry, the knowledge is there that each one is a worker in that industry. The co-partnership section of the President's address is such a very cogent presentation of the case for giving workers an interest in business distinct from the narrow wage-earning one, that those present listened to it with rapt attention—all no doubt wishing that they could persuade the administrators at home to see things in the same light as the President, and before him Sir George Livesey and others, and with him now many more. We come towards the end of the address where are traced the existing conditions, which complete the reasons for the fullest rejoicing at this jubilee. For never, competition on every side notwithstanding, has the gas industry shown greater economy in its working, nor such strength and promise as it does to-day. With the dying away of the final words, there was such applause that really rendered superfluous the formality of tendering a vote of thanks to the President. But convention must be studied; and so Mr. J. Ferguson Bell represented the thoughts of the members, and proposed a vote of thanks which Mr. William King gracefully seconded—he being able to claim a friendship with Sir Corbet in the past that commenced while yet both were in the springtime of professional experience. The President, in his reply, reminded that it was peculiarly meet that Mr. Bell should have proposed the vote of thanks, as it was due to him—to his graceful relinquishing of succession to the presidential chair—that he (Sir Corbet) was the President on this special occasion. This brought to a close the first sitting, which had all through been of such striking interest.

The Benevolent Fund.

On Wednesday morning, the first matter to occupy attention was the Benevolent Fund. During the transaction of this business and beyond, the President of the Illuminating Engineering Society (Professor Silvanus P. Thompson) was present; and later on Mr. Charles Hawksley was an honoured visitor. It appeared from the financial statement, that the Benevolent Fund Committee had expended £20 more during the year than they had received; and this induced the President to extend an urgent invitation to the members of the Institution to become contributors to the fund. What is wanted, he pointed out, are not large subscriptions, but a small contribution from each member, in order to maintain the fund in a satisfactory condition. The report was adopted; and Mr. W. Doig Gibb and Mr. Charles Meiklejohn were elected to the Committee in place of the retiring members.

Refractory Materials.

The report of the Refractory Materials Committee was the next subject for consideration; but prior to its introduction the Hon. Secretary (Mr. Shoubridge) read messages of congratulation from the German Continental Gas Company and from Mr. Walter R. Addicks, the President of the American Gas Institute. To return to the report of the Committee, Mr. James W. Helps has retired from the Chairmanship; and Dr. Harold G. Colman, who has been acting as Chairman during Mr. Helps's indisposition, was not able to be present. Mr. F. J. Bywater submitted the report, and pointed out its cardinal features. The Committee have been investigating how the first section of the specification is being worked by the manufacturers; and, as a result of tests made by Dr. Mellor of fourteen samples of retort material purchased to specification by different gasworks, it was found that two of the samples fell below the conditions for refractoriness, and two for contraction. In regard to porosity all were above the minimum. But some of the material would probably be better for being a little less porous, owing to the increase in physical strength which would thereby be effected. Both Mr. Bywater and the President particularly accentuated a passage in the report, which urges that engineers should always have tests made if they wish to ensure obtaining material of uniform quality. There is no question that some engineers who have purchased material under the specification have not obtained satisfaction; and Mr. Bywater thinks part of the blame for this should be borne by the manufacturer, because there is nothing in the specification that should cause retorts to be physically weak. This is endorsed by Mr. Edward Allen, who considers that some manufacturers have gone a little too far in "improving" retorts in the direction of porosity.

Improving Coke at the Expense of the Retorts.

On this point, Mr. Allen remarked upon the fact that some gas engineers are improving their coke by introducing something into the retorts which appears to have a bad effect on them. In the discussion on Dr. Davidson's paper later in the sitting, Mr. H. Kendrick mentioned that one process involves the putting of alkalis into the retort during carbonization. He has been in the habit of charging a particular setting for the purpose of improving the coke in this manner; and the retorts are in a much worse condition than those in the neighbouring settings that are not so treated. It was only on reading the papers prepared for this meeting that he found this condition was due to the alkalis.

Fifteen Thousand Cubic Feet per Ton.

To return to the report of the Refractory Materials Committee, there is still dissatisfaction with the specification on the part of Mr. W. B. Randall; and he contends that, so long as the tests are conducted in an oxidizing atmosphere and not in a reducing one, they are fallacious for the purpose in view. He likes to work to higher temperatures than are provided for in the specification. At present, he claims a make of 15,000 cubic feet per ton of coal, and he believes that, if the manufacturers would only supply the right material, a greater make than this would be possible. Naturally, Mr. George Helps (as do many others) thinks the 15,000 cubic feet claim is something worth inquiring into. The obvious response for Mr. Bywater to make to Mr. Randall was that it is only fair to the Committee to say that, if they have failed in helping their critic to get what he wants, he has also failed to help himself. What, too, Mr. Bywater would like to know is whence the material is to be obtained that Mr. Randall requires. The last-named gentleman also criticized the methods of making temperature tests. He mentioned that he lately wrote to the National Physical Laboratory to assist him; but they are unable to do so under present circumstances. There appears to be something with which the National Physical Laboratory do not see eye to eye with the Committee; but the Committee have failed to elicit from them what it is. As Mr. Bywater says, "We cannot compare, in this particular matter, the people at the National Physical Laboratory with men like Dr. Mellor, who has devoted his professional life to this work."

Silica Material.

Lately we have been incidentally hearing of the extending use of silica material in America; and, at this stage, Mr. Ernst Körting stated that, in recently travelling in America, he has been struck by the considerable extent to

which silica material is being used. It has been particularly introduced in connection with coke-ovens; and higher temperatures enables charges that formerly occupied thirty hours to be carbonized in 14 to 15 hours; and the ovens at the increased temperatures keep their form well. There was confirmation from Mr. R. M. Searle (of Rochester, N.Y.), who, it will be recollected, read a paper on high-pressure distribution at the Dublin meeting in 1907. He says the results that are being obtained in America with silica material are so marvellous that it is worth serious consideration here. It is believed that the conductivity of the material is more rapid and efficient, and that the heat is applied much more efficiently to the coal.

Coke-Ovens for Gas-Making.

Now we turn to the papers; and already it looked as though the discussions would have to be rushed through, the arrangements notwithstanding as to digests of papers only being given by the authors.

Some of the old arguments against the use of large chamber or coke ovens for gas making do not prevail to-day. Latter-day experience from the Continent has assured us of this; and home experience is confirming it. Beyond the small installation in Wales described the other day at the Welsh Association meeting, Birmingham is really the only place (but it is making a good beginning) to which we can look for solid experience at home as to the use of coke-ovens as an integral part of a gas producing plant. The changing legislative views as to the standard of quality for gas has opened the door wider than ever before for coke-oven application in gas-works, though adoption must always be largely dominated by the market for metallurgical coke. Where there is a good market, there the coke-oven will in future stand an excellent chance.

In the paper which was the first to claim attention, Mr. W. Chaney told of the experience, technical and otherwise, of the Birmingham Gas Department with twelve Koppers ovens, specially designed for the production of town gas and furnace coke. If we said no more than that the Gas Committee have decided to increase the installation by an additional 54 ovens, it would be the strongest possible piece of testimony that could be advanced as to the value placed by them upon the system. But the technical details that Mr. Chaney supplies in his paper are of remarkable interest and suggestiveness. The ovens are heated by the gas from Mond producers; and when the installation is enlarged, the producers will be worked under ammonia-recovery conditions. The author gives a description of both producers and ovens, as well as an outline of the oven-heating arrangements—one feature of which is the preheating of both the producer gas and the secondary air. The point of ignition of gas and air is directly opposite the bottom of the charge, so that the greatest amount of heat is applied at that part of the oven in direct contact with the coal—the sole and crown not being subject to any intense heat. The ovens are 35 feet long, 8 ft. 10 in. high, and taper in width from 18 inches to 19½ inches. The coal for carbonization is first broken to about 1¼ inches cube; and to produce a dense furnace coke, it is ground to fine dust by disintegrators. There are two ways of charging the ovens—by trolley along the top, or else by being pressed into cakes by means of a stamping-machine. The weight of charge per oven is from 8 to 10 tons; and the period of carbonization for stamped coal about thirty hours, and for unstamped coal 24 hours. The coke is discharged into a Goodall coke-quencher, by means of an electrically driven ram; electric current being generated by means of the gas from the outside producers. The gas from the ovens passes away by take-off pipes, connected to a dry collecting main, through which cold thin tar is pumped.

Outside Producer Results.

It will be understood that the plant with which Mr. Chaney is dealing is of a trial character. The producer works under non-recovery conditions, and without the necessary plant for tar and dust extraction. Consequently, the plant is not operating under the most favourable circumstances. In early tests, it is seen, the average calorific power of the producer gas was 130 B.Th.U. net per cubic foot, working with small coal and coke dust in equal proportions. When small coal was used, the calorific value of the gas was 147 B.Th.U. net; the approximate yield per ton of fuel being 130,000 cubic feet, and the fuel consumption 15·73 per cent. of combustibles on the raw coal carbonized. A table in the paper gives the cost, per ton of coal carbonized, of heating coke-ovens, using outside producers with ammonia recovery. With uncompressed coal, 12 per cent. of fuel on the coal carbonized is taken. Using coal slack only in the producers at 10s. per ton, the total heating costs, including sulphate recovery, and deducting the value of sulphate at £13 per ton, works out to 14·10d. per ton of coal carbonized. Under precisely the same conditions, but using half coal slack and half coke dust (at 1s. 6d. per ton), the cost works out to 12·37d. With compressed coal, 15 per cent. of fuel is used; and the net costs of heating are, under the respective conditions mentioned above, 16·46d. and 14·29d. Heating ordinary retorts by regenerative furnaces, based upon 12 per cent. of fuel per ton of coal carbonized, Mr. Chaney calculates the cost of heating at 23·9d. per ton of coal, including coke, labour, repairs to furnaces, stokers' tools, and depreciation. Therefore, while there are losses of sensible heat by radiation and conduction, with outside producers, the recovery of ammonia, the use of an inferior fuel, and the liberation of coke, are economies well worth attention by engineers.

Results from the Ovens.

In considering the working of the coke-ovens, there are points that must be borne in mind. In the matter of coal selection, an expanding coal is not desirable, owing to the difficulty of discharging; the sulphur and ash content are also important factors; and the influence of alkali salts has also a bearing upon the life of the oven walls. As to results, in early experimental work with 50 per cent. of South Yorkshire coal, and 50 per cent. of Derbyshire, the gas made per ton of coal (corrected) was 12,640 cubic feet of 17-candle power with the No. 2 burner, and of a calorific value of 500 B.Th.U. net. There is no complete information as to the tar and liquor produced, owing to the impossibility of yet isolating them. But the yield of liquor appears to be quite equal to that produced by other systems of carbonization, and is certainly more than where stoking-machines and horizontal retorts with single ascensions are used. The tar is shown by analysis to be of good quality; and the free carbon content is only 3·5 per cent. Regarding the coke, a table indicates that the percentage of breeze is only 9·4, and dust 2·9; so that coke stands at the high percentage of 87·7. In Birmingham, the price of furnace coke is several shillings higher than that of gas coke. It is estimated by Mr. Chaney that the life of the ovens should be about six years, and that the cost of repairs should not exceed 3d. per ton of coal carbonized. The estimated labour costs—coal to crushers, and coke to railway waggons—including machine men, gas regulator men, tar attendant, coal unloading, and odd men, are 7·3d. per ton of coal for stamped charges, and 5·8d. for the unstamped charges (the men employed upon the Mond gas plant are excluded). This paper will do much to advance consideration of the use of the coke-oven as an economical method of gas production in works from which a market can be obtained for metallurgical coke.

Criticisms Freely Answered.

In accordance with the arrangement, Mr. Chaney read an abstract of the paper; but there were so many interesting features about it, that here and there he was tempted to break away from the prepared manuscript. The discussion was well sustained; being more critical than anything else, for the purpose of eliciting additional information on points that troubled, or rather arrested the attention of, members. Those who contributed to the debate were Mr. J. W. Morrison, Mr. J. F. Bell, Mr. F. J. Bywater, Mr. W. R. Herring, Mr. E. Körting, Mr. Thomas Glover, Dr. Lessing, Mr. H. D. Madden, and Mr. G. S. Sayner. There appeared to be some little disposition to defend the existing systems by searching for defects in the coke-oven system. But it is remarkable how the criticism failed before the knowledge derived from experience. There was the question of the capital cost of the installation; but, when comparables are taken, it is found that there is not much difference. For instance, the coke-ovens eliminate the retort-house; and when it is seen that the outside producers, with ammonia recovery, earn their own living—recovering sufficient to pay for the capital outlay involved, and supplying cheap heat to the ovens—this part of the

system can be isolated entirely from the other part. Under such circumstances, the introduction of the outside producer may be an economic proceeding. Until these matters were pointed out by Mr. Chaney, there were members who could not see any economic advantage in the coke ovens, who saw in them the introduction of an additional complication into gas-works, and who—this was Mr. Herring—thought that the ammonia-recovery gas-producers meant buying special coal for them. He considered, in fact, it would be better to strip part of the gas, and use it for heating the ovens. But the gas is wanted for supply purposes; and as to purchasing special coal, there is no need to do so, for (we learn) high ammonia results can be obtained from these producers by using coke—70 lbs. per ton, which is a remarkable thing.

Some point was also made as to labour charges for the ovens. But there, again, Mr. Chaney could say that these—taking comparable items—only work out to 4·9d. per ton on the stamped charges, and 4d. on the unstamped charges. There was reference to the injury to the sides of coke-ovens, if the coal is not purified from calcic chloride. The colliery people had better pay a little heed to what Mr. Thomas Glover says on this point. He accuses them of not now properly washing their coal with water, but contenting themselves with using "mud," which naturally has a considerable effect upon the amount of ash produced. There was not much criticism of the working results of the ovens, because, as a matter of fact, they are much on the lines of those obtained from ordinary gas-works operation. But Mr. Körting wants us to remember that primarily we are gas makers; secondly, that 30 per cent. better results can be obtained from the vertical retort system than from coke-ovens; and, thirdly, that the more gas one can produce per ton of coal, the less, in relation to the quantity of gas produced, is the amount of coke for disposal. This is an important matter to keep in mind. But it is not the only one. There is the question of the character of the demand for coke in a district, and of the quality of coke required. As Mr. Herring says, it might pay to have two or three kinds of carbonizing plant in a gas-works to meet the varied coke requirements. In the industrial districts, ordinary gas-works coke is meeting with great competition from metallurgical coke; and the position that Birmingham has taken up in connection with this is admirably stated by Mr. Chaney. Let us put it in our way: Many thousands of tons of metallurgical coke were sent into Birmingham from outside. If, in producing the gas required in the supply area, the Gas Department satisfies this demand for metallurgical coke, it at once reduces the ordinary coke for sale from the works by the extent to which the local metallurgical coke market is captured. That is to the good. Railway carriage, too, is saved, compared with the cost of sending coke from the more distant colliery ovens. Against this, Mr. Körting points out that the metallurgical coke is only of use for its special purpose, and its maximum use is in times of boom; while at other times compulsory production may cause it to be a drug on the market. To which Mr. Chaney answers that, by charging the ovens from the top, a good domestic coke can be made. Mr. Glover is of opinion from his experience that, in order to obtain an approximate standard foundry coke, it is necessary to always use one class of coal.

Liquid Purification.

Succeeding came the paper by Dr. W. B. Davidson, of Birmingham. This is a communication that should not be lightly passed over—in fact, it cannot be if readers are going to properly digest the excellent composition. We at all events find it impossible to review the contents in short space. There is a rich amount of information here, and a comprehensiveness of survey within the reasonable limits of such a contribution, which supply further testimony to the thoroughness with which the author deals with all matters he takes in hand. Losses in gas-works are largely due to neglect of details; and the details contained in this paper may be strongly recommended to the study of the responsible technical officers of gas-works. The impurities considered by the author are tar, ammonia, naphthalene, hydrocyanic acid, sulphuretted hydrogen, carbon bisulphide, carbon dioxide, and hydrogen. The two last-named impurities are included on account of their efficiency deteriorating influences upon the gas.

Tar Removal.

The importance of considering the construction of carbonizing plant in relation to bye-products is shown at the outset of the paper in dealing with tar. With ordinary gas coal, tar at 3d. per gallon may reach the value of 3s. 6d. per ton of coal carbonized; and certain designs of vertical retorts may produce as much as 5 gallons of tar more than horizontal retorts, with one ascension-pipe, working at high temperatures. The object of the communication is to consider the question of efficiency and cost of extraction; and, right in the forefront, we have the author stating that he does not think vertical retorts have been designed so as to successfully reduce to a minimum the cost of tar-handling in the retort-house. He suggests circulating hot tar through the hydraulic main, and providing agitators for moving the contents before running off. With verticals, too, he finds difficulty in the stoppage of retort-house governors by carbon, dust, and pitch. This is rather curious, when it is considered that vertical retorts produce only 3 to 4 per cent. by weight of free carbon. Evidence points to the advisability of the claim as to the production of thin tar with verticals being taken with the proverbial grain of salt. A remedy for tar-pipe stoppages through the formation as small crystals of ammonium chloride, is the introduction of water or liquid into the hydraulic main at definite intervals. Referring to the corrosive action of ammonium chloride on steel, the author mentions that efforts are being made in some coke-oven plants to collect the ammonium chloride solution from the hydraulic main, and then to concentrate it by working it round until it is strong enough to profitably crystallize out the salt. Another point is that sodium chloride has a deleterious effect on the internal walls of retorts and ovens. Owing to the nuisance to the tar distiller of the presence of ammonium chloride, the author considers it better that the gas maker should sell it in the liquor rather than in the tar. Dr. Davidson speaks well of Feld's centrifugal washer, which facilitates the liquid purification of enormous quantities of gas at much reduced cost. Unless the gas maker looks carefully after tar removal, there may be a large loss of benzene from the gas, through extraction by tar, by too drastic condensation or prolonged contact with the gas; and further the presence of a few grains of tar per 100 cubic feet is sufficient to render the ammonia-washers inefficient. The amount of tar in the gas entering the first ammonia washer should not exceed 2 grains per 100 cubic feet of gas. Even the small amount of 4 grains is prejudicial to cyanogen extraction in the presence of tar. Omitting the cost of removing pitch from the hydraulic, the special charges against tar purification beyond the condensers probably do not amount to more than 0·25d. per ton of coal carbonized, calculating on a plant dealing with 100,000 tons of coal per annum. Mention is also made of high-pressure tar-spray washing, and the use of the finishing tar-extractor.

Ammonia.

It is clear that for bye-product efficiency, Dr. Davidson does not like horizontal retorts with a single ascension-pipe. He made a point of it in connection with the tar, and again, in dealing with ammonia, he alludes to the fact that, while the maximum production is obtained with vertical retorts, the single ascensioned horizontal retort produces the minimum. Sold as liquor, the value of ammonia sometimes reaches 3s. 4d. per ton of coal carbonized. Touching the ordinary practices for the removal of ammonia, the author refers to the difficulty of washing out the last traces. However, with water at a temperature of 50° Fahr. or under, and the strength of the liquor effluent from 4 to 6 oz., the ammonia passing the final washer should not exceed an average of 1 grain per 100 cubic feet of gas. It is, however, feared that, owing to want of proper regulation of wash water, breakdowns, and tar troubles, the losses are often much greater. Anything approaching the old limit of 4 grains of ammonia per 100 cubic feet in the gas supplied to the district deserves the strongest condemnation as wasteful. But while an efficiency of 99½ per cent. total extraction looks highly satisfactory, it may not represent the real efficiency, as, owing to the volatile character of ammonia, much may be lost on the works, if the precaution is not taken of carefully enclosing supply jets and overflows, and covering-in tanks and troughs. Several points are made regarding this and other aspects of the ammonia question; and then the author gives

the cost of ordinary ammonia washing (interest and depreciation included) as 1¾d. per ton of coal on a large plant.

Naphthalene.

Naphthalene, valuable for its candle and calorific values, but troublesome in other respects, is next dealt with. It is not, however, so much the amount of naphthalene present that determines the necessity of purification as the proportion of vapour of heavy oils that will condense out along with the naphthalene, and keep it in solution. The author outlines the advantages and disadvantages encountered in the different systems of dealing with naphthalene—giving preference, on account of cheapness, to introducing into the gas a sufficient quantity of the vapours of oils having a somewhat lower boiling-point than that of naphthalene—though there are certain described drawbacks, to which are set-offs in the improvement of the quality of the gas and the increase in volume. The amount of oil requiring to be vaporized depends on the nature of the gas; but, as a rule, 10 gallons per million cubic feet suffice. Suitable oils can be prepared from carburetted water-gas tar. The cost of the preventative process favoured, on a 100,000 tons carbonizing plant, is estimated as being 0·46d. per ton.

Hydrocyanic Acid.

Coming to hydrocyanic acid, it is found that the highest yield is obtainable from horizontal retorts, heated to high temperatures, and possessing only one ascension-pipe; and the lowest yield is from intermittent vertical retorts. There, again, working is in favour of the latter, and against the single ascensioned horizontal. For preventing corrosion and stoppages in services, it is desirable that the hydrocyanic acid should be removed as completely as possible. Considering the extraction of cyanogen for sale, the author points to the small commercial incentive that exists owing to the low price of prussiate of soda. A prussiate plant is rather costly; and it is suggested that for small gas-works sulphocyanide production will be found more profitable. From Dr. Davidson's experience of manufacturing sodium prussiate liquor of about 10 per cent. concentration, the cost works out to 2d. per ton of coal.

Sulphur Impurities and Inert Gases.

Sulphuretted hydrogen is an impurity over the estimation of which a great deal of laxity prevails, probably owing to the simplicity and convenience of the oxide of iron process. Some figures in the paper show that the highest percentages are obtained with horizontal retorts working with single ascensions, using the same coals, though coals from the same districts show considerable variation between the highest and lowest yields. The author gives an estimate for a complete plant for oxide purification and sulphur recovery, the net cost of which works out to 7·4d. per ton of coal carbonized. In treating of carbon bisulphide, there is mentioned the aid rendered by vertical retorts in the reduction of sulphur compounds; but the diminution is rather uncertain, being much greater with some coals than others. The author does not describe—probably not desiring to overburden the paper—various processes that have been put forward for securing reduction. Again, it is seen that the highest amount of impurity in this connection is with horizontal retorts with single ascension-pipes; and when we come to carbon dioxide, the same result is found. The higher the moisture in the coal, too, the higher the percentage of carbon dioxide. The author also alludes to the effect of a strong exhaust; as well as to the depreciation of illuminating and heating values by high carbon dioxide content. We have Dr. Davidson saying here that it does not appear to him that there is any "justifiable ground for assuming that town's gas need have no luminosity except with incandescent burners, so long as practically every householder who is a gas consumer thinks he must have one or more flat-flames in his house." The consumer has to be taught that he is making a mistake, and that the gas industry cannot be held up by such a fancy as that. Flame temperature is, of course, improved by the removal of the carbon dioxide. When illuminating power is important, the elimination of carbon dioxide is worth a great deal; but where the standard of illuminating power is low, the only advantage to be gained is increased flame temperature. Then it is a question whether the improvement would compensate for the cost of carbon dioxide purification. Regarding the nitrogen, it is much less harmful to candle power than carbon dioxide; the reduction for 1 per cent. addition being 2·6 per cent. for the former, as against 3·5 per cent. for the latter. It is a diluent so far as heating power is concerned; and the heat units are reduced just in proportion to the percentage added. Its effect on flame temperature and incandescent lighting is not very marked.

Promising Development of Ammonia for Purifying.

We come to the end of the full paper; and there we have promise of development in a direction in which hopes have often been shattered. Dr. Davidson refers to the failures of the past in using the alkaline properties of ammonia to purify gas from the acid impurities, sulphuretted hydrogen, and carbon dioxide; the early workers not having discovered the true science and art of distilling gas liquor. At the Birmingham Gas-Works, however, it is believed that all the problems necessary to success have been solved. Two years ago a liquid purification plant was started on the coal test plant for the treatment of the gas made by the trial installation of Dessau retorts; and after twelve months' trial, the process of extracting sulphuretted hydrogen and carbonic acid from the gas by means of a purified ammonia solution has been pronounced successful. The author does not go into the matter to any extent on this occasion; but he promises to let the gas profession hear more concerning it at a later date. Meantime in regard to distillation, the chief improvement that Dr. Davidson has introduced is the employment of a carefully regulated gradation of pressures in the still, in addition to the control of temperatures. The wonder is that previous experimenters did not hit upon this very obvious aid to the separation of ammonia, sulphuretted hydrogen, and carbon dioxide—pressure having a most important influence on the solution of all gases. In regard to washing, the advent of the vertical centrifugal spray washer makes the task very much easier. It is not intended as a regular thing to remove every trace of sulphuretted hydrogen by means of ammonia. But at least 96 to 98 per cent. is removed; the final traces being taken out with ferrous hydrate sludge, which goes to the primary cyanogen washer. Important is the statement that the cost of complete liquid purification plant for a large works promises to work out at a comparatively low figure per ton of coal carbonized. The gas profession will be anxious to learn more of this process which Dr. Davidson introduces so modestly at the end of his paper.

A Discussion on Details.

It was recognized by the President and Mr. Edward Allen that the gas industry are large debtors to the Birmingham Corporation Gas Department for the considerable amount of valuable research that is now carried out at their works, and which places the gas industry in possession of much that is of value. Sir Corbet regretted that Mr. R. S. Hilton, the General Manager, was too unwell to be present at the meeting, in order that he might have personally communicated these views to him. However, the discussion that took place on Dr. Davidson's paper was largely on details, and not general points which lend themselves to review apart from the ordinary report of the discussion. Mr. Allen, Mr. C. Dru Drury, Dr. Lessing, Mr. W. W. Townsend, Mr. R. Wardell, and Mr. H. Kendrick were contributors. The announcement made in the closing part of the paper, as to the probability of Birmingham giving the gas industry a successful liquid purifying process, and a simple one too, was something that attracted curiosity. Mr. Allen, among others, was anxious to know more about it; and he urged Dr. Davidson to hurry up with working results, in order that those who are contemplating putting down new purifying plant may know what to do. But these are things that cannot be hurried or done all at once; and the Birmingham Gas Committee are not likely to entertain the expenditure of capital on anything of this kind until it is absolutely needed, especially in the present position of the coal market.

One of the many other points made was in regard to the washing by hot tar of crude gas. Mr. Allen says that he has attempted this on the gas as it leaves the foul main; but the condensers which came next were soon blocked with naphthalene. He finds a "Simplex" washer a good thing

for reducing the naphthalene trouble. Mr. Townsend says it is quite possible to diminish the naphthalene simply by the use of the natural solvent capacity of the coal tar. But why make impurities? asks Mr. Drury. Prevention surely is better than cure. Working with the Dessau retorts, he finds only 21 grains of sulphur per 100 cubic feet after oxide purification, and no trace of naphthalene. The claim of the author, that the use of oil vapours for obviating trouble with naphthalene caused the illuminating power and calorific value of the gas to be improved, was questioned by Mr. Allen, who has experienced, after the use of oil vapours, the depositing a distance away of naphthalene, and the dragging down with it of other hydrocarbons. But Dr. Davidson points out that the deposit is not so much as the amount of vapours put in; so there must be some improvement in the illuminating and calorific powers.

A suggestion by Dr. Lessing was that the author should use in his final washer ferrous sulphate, leaving the ammonia in the gas to separate the ferrous sulphate, and make a sludge from it, so as to do away with the alkali. But Dr. Davidson sees certain objections; and so it has not been thought worth while to try it. As to carbon bisulphide, Dr. Lessing mentioned a new process under trial on the Continent in which removal is proposed to be effected by alkalinated cellulose. Among other points, it was noticed by Mr. Kendrick that the author had not referred to the absorption of ammonia process introduced by the Simon-Carvès Coke-Oven Company for direct recovery. Upon this Dr. Davidson thinks if 99 per cent. efficiency can be obtained with water, there is no need to trouble about an acid method.

Industrial Gaseous Heating.

There was a short time before the hour fixed for the adjournment; and as the first business of the meetings had made such heavy claim, the President rightly decided that no time must be wasted, and therefore, Mr. E. W. Smith and Mr. C. M. Walter were asked to introduce their paper on industrial gaseous heating. Mr. Walter read the abstract. Singularly, this is the third succeeding paper from Birmingham; and all on diverse subjects.

The development of the industrial heating branch of business having been taken seriously in hand by various gas undertakings, and its cultivation now receiving a more widespread attention, it is useful to have as much enlightenment, from experience, upon it as possible. A large amount of information from experience is given in the paper. We have to thank Birmingham for much light and leading in this direction. Quite at the outset of the contribution, the premier importance of calorific power is introduced; and the writers point to what has been commonly accepted, that it is of much more importance that the quality of gas should be fairly constant, than that it should be high. They suggest that a satisfactory gas for town supply is one averaging 520 B.Th.U. net, and not varying from this figure *plus* or *minus* more than 3 per cent. In areas where the consumers are accustomed to a gas of between 14 and 15 candle power, there would be a preference on the part of gas makers for a figure lower than the one proposed by the authors, which is above those that have been made at home the subject of statutory requirement. It is rather a pity that there should be these suggestions of higher calorific values at the inceptive stage of the industry's transition from illuminating power to calorific value standards. In speaking of the use of water gas for enrichment purposes, the authors urge that specific gravity should not be allowed to vary greatly, as the volume of the gas passing through the jets of the apparatus in which the gas is being burnt will vary inversely as the square root of the specific gravity of the gas. In furnace working, the increase in density is equivalent to a drop in the calorific value of the gas. With serious variations of quality, the aëration of the mixtures in the burners will also vary. The authors are looking for still greater refinement in gas purity; and they believe the time will come when gas undertakings will find it necessary to completely abstract the sulphur compounds. The quantity of gas used in a furnace is likewise caused to vary with barometric pressure, and the temperature of the gas. Constant pressure is also an essential.

To Obtain High Flame Temperatures.

Having decided as to the proper characteristics of the gas for industrial heating, the authors refer to the design of melting-pots, and other structural features of settings, including an allusion to the duplex burner used, and the conditions found necessary to obtain the highest heating efficiencies. They then lead off into a consideration of certain of the factors that cause actual temperatures attained in flames to diverge widely from those calculated. The injury to temperatures by departures from the theoretical quantities of gases to obtain complete combustion is next introduced. Flames of coal gas and oxygen will have higher temperatures than flames of coal gas and air. With gas and air, the highest flame temperatures are realized when a correct and efficient mixture is made previous to combustion commencing—assuming that preheating either the gas or the air is out of question. To obtain correct mixtures, the authors prefer high-pressure gas and injected atmospheric air to air under pressure and low-pressure gas. The economic advantages and efficiency from using proper construction are illustrated in many places in the paper. For example, in soft metal melting in iron pans, the highest efficiencies are secured with the use of high-pressure gas and chamber burners—the conditions here being altogether different and more favourable than those existing when using even the best types of industrial low-pressure ring-burners. With the latter, the flame temperatures are from 200° to 300° C. lower than high-pressure gas-flame temperatures. Under specified working conditions, it is found quite possible to maintain white metal in a pot at 650° Fahr., with a consumption of 165 cubic feet, as against 250 cubic feet with low-pressure gas—a substantial saving, it will be readily admitted.

Varied Conditions.

Having dealt with direct heating, the authors consider the question of indirect (or radiation) heating. Radiant heating is the more efficient if the furnace linings are satisfactorily made, and the minimum amount of heat is allowed to escape through the furnace walls. In melting-furnaces, by the use of sectional block linings and antithermic cement, it has been possible to reduce the consumption by some 15 per cent.; the temperatures and times of melting being the same as employed with the old type of linings. Reference to surface combustion is inserted in the paper. Birmingham is a city that has much to gain by improvements. The authors, however, have apparently some fear on the ground of wear and tear under normal works' conditions; and no evidence has yet been forthcoming of long-period practical tests. We cannot indicate here the contents of the part of the paper dealing with the controlling factors in air injection, although the authors make quite a learned show with their theoretical considerations and formulæ. They pass on to a description of the work that has been done in the matter of the application of gas to Birmingham glassware manufacture. In one case some glory holes are heated by gas at a pressure of 12 lbs. per square inch. At about this pressure, no secondary air is required—sufficient primary air being injected to obtain complete combustion. The usual working temperature is about 1400° C.; but temperatures as high as 1500° C. have been obtained. As regards fuel cost, it is found that, with gas at 1s. 2d. per 1000 cubic feet, it works out about equal to that of solid fuel; but the advantages are on the side of the gaseous fuel. At first, when dealing with glass containing a high percentage of lead, a "sulphuring" effect was produced by the gas. This was found to be due to the presence of a naked flame in the hole; and remedy was found by causing the combustion of the gas to be concentrated on the lining of the hole—thus eliminating any naked flame from the centre.

Leaving the extensive information that is given on the subject generally, the next section of the paper treats of tempering, hardening, and annealing furnaces. In the oven furnace, with the bottom slabs heated by the large flames from atmospheric burners, just the effect is realized that is needed in these soaking processes; the poorly aërated flame which partly envelops the work being an absolute necessity for the best results to be obtained. If suitable arrangements are made to control the amount of secondary air entering the furnace, the work can be carried out with the minimum of oxidation. Any temperature up to 1200° C. is maintained quite easily with a gas pressure of from $3\frac{1}{2}$ to 4 inches. Detailed information is given as to the construction of, and working methods with, such furnaces.

Furnace Construction.

There follows a disquisition on general furnace construction. The importance of the conductivity of fire-clay is emphasized; as it is apparent that in large muffles and ovens, where a considerable body of heat is required, knowledge as to the conductivity of the fire-brick employed is of importance in determining the thickness of wall to give the most economical working. The time occupied in heating up depends largely upon both conductivity and thickness of wall. In large furnaces, where much heat is absorbed by the brickwork during the preliminary heating up, the more economical method of working is to arrange for a small number of burners to be kept on continuously, to maintain a temperature of not less than 600° C. during the period in which no work is being carried on. Not only is fuel economy thus attained, but maintenance cost is reduced. More structural and working hints appear; and incidentally the "S.W." high-pressure blow-pipe is referred to—one improvement being in the simplification made in the controlling arrangement.

Compressing Plant.

In the concluding part of the paper consideration is given to the installation of compressing plant where a public high-pressure supply is not available. Rotary compressors can only be used where the working pressure does not exceed 5 lbs. per square inch; but even at this pressure, if a large output is required, it will pay to instal reciprocating plant, owing to its greater mechanical efficiency. Systems of pressure control are discussed; and the authors appear to favour the system of unloading the compressor on the suction side when the pressure in the receiver rises above some predetermined limit—the operation being performed by inserting a specially constructed valve (operated by the pressure in the receiver) on the suction side of the compressor. With such a system, as compared with a bye-pass valve, a considerable saving of energy is effected if the load on the outlet varies within considerable limits. A reference to the energy expended in gas compressing brings us to the important one of costs. It may be taken that for compressors of a capacity up to 10,000 cubic feet per hour, the capital outlay invested in plant will be about £25 for each 1000 cubic feet per hour delivery capacity, and that the total compressing costs—including interest on capital, depreciation, &c.—will amount to about 1·75d. per 1000 cubic feet of free gas, compressed and delivered at a gauge pressure of 12 lbs. per square inch. The figure is based on the assumption that the compressor is driven from an already existing line of shaft. The paper will be very valuable to inquirers into the subject.

Stove Prices, Coke Contracts, and Labour Exchanges.

Conformably with what has now become custom, in the afternoon there was a joint meeting of the Commercial Gas Sections of the United Kingdom. Several subjects were discussed. There is discontent with the gas-stove makers for not falling in with the proposal to have a conference on the subject of the rise in prices with representatives of the Commercial Sections. Negotiations to this end have so far failed; and the Commercial Sections are surprised. They resolved to strengthen the suggested deputation, and to continue the negotiations for a conference with the stove makers. There ought to be some explanation forthcoming as to the reticence of the gas-stove makers in this matter. Perhaps it is to be found in the fact that their first offer was to submit their evidence on the subject to representative men of the industry on the Council of the Institution. They may not regard the Commercial Sections as occupying the same position as the Council. We cannot tell; and it would be as well for them to frankly avow the reason. A further matter that was discussed referred to the sales of surplus coke. The Commercial Sections were asked, by resolution, to go carefully into the question of selling such coke by tender, and to make thorough inquiries before selling coke to dealers. Standard clauses for coke contracts are also to be considered. A matter of considerable importance is the lighting of Labour Exchanges. There was a discussion upon it, which divulged different experiences. Mr. Goodenough does not find that in London at any rate there has been any inflexible decision arrived at as to gas not being used in the lighting of Labour Exchanges. This being so, then it is for one of the representative organizations to find out why a gas engineer received from the Labour Department a letter in which it was expressly stated that instructions had been given to use electricity where it was available; also as to why Mr. John Carter and others have had the experiences upon which there has been information advanced. It was understood from Mr. R. G. Shadbolt that the Parliamentary Committee of the Institution have the matter in hand; and they have found it impossible up to the present time to trace any definite instruction of the kind. What has been done with the view of tracking-down the matter is not known; but it would certainly be well to ascertain from the Labour Department what was meant by the official letter sent to a gas engineer in the North.

A Disappointing Discussion.

Good intentions sometimes meet with disappointing ends. The Council had sought to make discussions more valuable by asking members to indicate their intention of taking part in them. It was not therefore the fault of the Council if certain of the discussions at the final morning's sitting were not what they should have been. The pre-listing of speakers has proved a lamentable failure. Those who were expected to speak on the excellent paper by Messrs. Smith and Walter were not all in attendance at 10.30, to take part in the discussion after the reading of the congratulatory message from the President and members of the Société Technique engaged in their annual conference at Toulouse. At the opening, there was a small attendance; it increased, however, in strength as the morning proceeded. Mr. J. H. Brearley was there, and did his duty; and brief contributions were made by Mr. F. W. Goodenough and Mr. W. A. Twine. The valuable work of Mr. Smith in relation to the question of the use of gas for industrial heating purposes was acknowledged by Mr. Brearley; and he agreed as to the importance in heating work of uniformity of pressure and calorific power. Information was sought on various points; but they are not of a nature that can be dealt with in much briefer space than is required by the full report of the remarks made. To the verbatim report therefore in other columns readers must turn. But there was clear disappointment on the part of Mr. Smith that there had not been a greater discussion, as the paper had been purposely designed so as to bring out controversial points. As calorific power is so much in the air, and as Professor Boys and others had dealt with the question during the after-dinner speeches the previous evening, he had particularly hoped the matter would have evoked a lively discussion. Mr. Smith wishes to go farther than a calorific standard, by not overlooking, in conjunction with it, a standard of flame temperature. The question of surface combustion was one of the points raised by Mr. Brierley; and Mr. Smith on this stated that certain pieces of surface combustion apparatus that have been in use in Birmingham have not been a perfect success. Ordinary works managers want a considerable life in any apparatus that they instal. There was also a contribution, in reply to the discussion, from Mr. Walter; and he explained, concerning the preheating of the air, that the reference in the paper only applies to the secondary air. If the primary air were heated, the necessary mass of air is not obtained. Regarding compressors, it is found that, for pressures above 5 lbs. it is, from the commercial point of view, more efficient to use compressors of the reciprocating type.

Ventilation and Gas.

Here the President made an announcement that, in view of the pressure on time, Mr. S. B. Langlands, of Glasgow, was willing that his paper should be taken as read, and not discussed. However, a brief reference may be made to its contents.

The ventilation of the rooms of our dwellings is a matter of great importance; but the present methods—common or specially devised—have not the characteristics about them that give them any title to be regarded as providing a continuous efficiency, and draughts are often an inseparable concomitant. The Institution are, as the report of the Council shows, undertaking, through the Leeds University, an investigation into the subject of ventilation, and the aid that gas is in contributing to it. Meantime, Mr. Langlands regards the matter as one for broad consideration, and tentatively he introduces in his paper a suggestion which

he would like to have tested, and which may produce further ideas. His proposal is to have porous ceilings and perhaps porous walls to the depth of a foot or so from the ceiling, so that the hot vitiated air may percolate through at a speed sufficient to keep the air sweet and wholesome in the room so treated. The speed would, of course, depend on the use to which the room was put, and the degree of porosity of the material; and, therefore, different materials and different thicknesses of material would have to be used, according to the requirements of the case. With such a method, the author believes that eventually the public generally would be brought to recognize in gas the only hygienic means of lighting and heating. Mr. Langlands does not leave his suggestion there. The question naturally occurs as to the nature of the porous material. He himself commenced to make trials with a wrought-iron box filled at top with a slab of Kieselguhr—a very porous brick, the chief constituent of which is diatomaceous clay. But his experiments with it were not carried far, through the pressure of other work. In the paper, he suggests several materials with which a trial could be made. Of course, where there are rooms above, the floors would have to be lined with some thin impervious material; and vent-shafts could be carried up to the roof. An important point in experimental work on porous ceilings would be the method of maintaining porosity, and as to the material which would be best for this purpose. The vacuum cleaner might find new service here. There is also the question of cost. In these days of "jerry" building of middle-class houses, builders would give first consideration to cost; and what of the several ceilings in each of the millions of houses now existing?

American Views on Depreciation.

There was great disappointment that Dr. A. C. Humphreys had been prevented from leaving America to be present at the Jubilee celebrations, and to personally read the paper that he had prepared on "Depreciation—Estimated, and Actual." His apologies were conveyed by the President. The paper was likewise taken as read. Dr. Humphreys is a man who, for his innate qualities and ability, has honour not only in his own country, but in this and other countries.

Early in the paper Dr. Humphreys used the expression "depreciation so-called." "So-called" indicates that, in the author's opinion, the term "depreciation" has assumed an elasticity that causes it to spread over an area greater than is perfectly legitimate. However, it is an important subject; and it is rather a complex one to compress into the limits of a paper. This Dr. Humphreys recognized directly he sat down to his task. Naturally, his treatment of the subject is more applicable to American conditions; but, the topic being one in which all concerned in industry are interested, it is useful to hear all sides in regard to it—more especially as there ought not to be great differences in respect of fundamental principles. But principles apart, there is no doubt, judging from the opening lines of the communication, that Dr. Humphreys is of opinion that there is something defective in the methods of adjudicating upon matters that are technical at their base. This is very obvious by following closely the introductory train of thought. In his experience, he has found, in certain cases, that representatives of legitimately invested capital have not sufficiently mastered the questions involved to qualify them to meet effectively their great responsibilities. On the other hand, while believing that Courts of Law do their best to arrive at just decisions, he is not prepared to say that their decisions from the point of view of justice are always final; and "certainly we should constantly keep in mind that, at least on many of the technical questions involved, we engineers are more competent to form a correct judgment than are the lawyers or judges." The paper is full of philosophical reasoning.

A Fatal Error.

It is further submitted that much of the error to be found in the opinions of commissions and courts is due to the acceptance of hypotheses as theories, which fail to meet the definition of theory because they exclude the necessary limitations of practice. One reason for misunderstanding in connection with depreciation (so-called) is the failure to appreciate that the questions involved are not comparable between a concern subject to governmental regulation and a commercial undertaking avowedly engaged in an open competitive business. In the case of a concern doing a competitive business, the distribution of profits may be kept low, and the balance be used to write-down plant account. In such a case, eventually we have the result that, to get a fair return on the full investment, the dividends are necessarily based upon what appears to the uninformed to be an excessive dividend rate. But if the full net profits have been distributed, and, as capital is required, the dividends are handed back in payment for additional stock, the conditions are not really changed. Yet in this latter case, there is no public question as to the rights of the stockholders. In respect of governmentally regulated concerns, Dr. Humphreys goes for illustration to the Massachusetts companies, in which there have been heavy writing-down, and charging of extensions against income. But what has been the result? Extremely low current capitals per 1000 cubic feet, and high dividends in relation to these capitals, have led to the imposition of excessive restrictions and compulsory reductions of price—all of which must, in certain instances, tend to confiscate portions of the legitimate investment. Therefore, the author regards it as a fatal error to write-down assets below their legitimate investment cost where subject to the opinions and control of those who have insufficient practical experience. Consequently, he roundly condemns unscientific and haphazard methods of writing-down assets, as working a direct injury to stockholders, and an indirect and potent injury to the industry as a whole by furnishing opportunities for comparisons which have no value. The low capital advocates in this country—those who have reached a low capital by doing precisely what Dr. Humphreys condemns, are supplying gas at a low price to-day, are in consequence benefiting their supply areas, and have so strengthened the concerns to resist electrical competition—will note what is said in the paper; but will console themselves that they are fully protected in what they have done by the sliding-scale of price and dividend, and by the impregnable position occupied in relation to competition.

Final Renewals, and Other Matters.

Dr. Humphreys proceeds to show the difficulties to which the American companies are subject in meeting rate assessment cases, in which depreciation plays an important part; and it is clear that, in the fights for justice, they have had to encounter unfair methods and many complications. Among other things, in such cases, the question of depreciation has been greatly complicated by being involved with the estimates made to cover each year's share of the cost of final renewal or replacement of plant, in order to spread over the life's service the cost of the portion of maintenance which is not covered by current expenditure for repairs and minor renewals. The final renewals estimate is supposed to include the elements of physical decay, obsolescence, and inadequacy. This leads Dr. Humphreys to condemn the practice of including in the estimate for final renewals some reserve for extraordinary hazards outside final renewals, as this introduces complication. If a division were made between final renewals on the one hand and contingencies and hazards on the other, the companies would be in a better position to support the three claims—(1) The inclusion of an annual charge for final renewals; (2) the inclusion of a reasonable charge for a fund to meet contingencies and hazards; and (3) the exclusion of a depreciation deduction from plant appraisals in rate-fixing cases. The argument proceeds on the assumption that the estimate of the annual cost of final renewals of the several parts of the plant is made on the basis of a compound interest sinking fund—the parts being grouped together according to the assigned expectation of life. The amount annually required for each group will be the sum which, accumulating at compound interest for the years assigned, will equal the cost of the plant, or the cost less the amount recoverable in disposing of the displaced parts of the plant.

Points to be Kept in Mind.

Thus we see that Dr. Humphreys presents three points to be kept in mind in connection with the study of the problems of depreciation: (1) The setting up of a reserve for final renewals; (2) the proper annual charge based upon an estimate or assumption of the effective life of each part of the plant, considering the elements of physical decay, obsolescence, and inadequacy; and (3) the loss not having to be met until the replacement is actually due, the fund should receive the benefit of interest accumulations until the

time for payment arrives. The author presents examples, and carries the exposition of his case further in the concluding part of the paper, especially considering the appraisal of plant for rate-fixing. In the final paragraph, there are safeguarding remarks. The author desires that it shall not be considered that anything he has said as to the determination of actual depreciation is to be taken as an admission that, in a rate-fixing case, any deduction should be made from the appraised cost to reproduce plant new to cover so-called accrued depreciation, or, more correctly speaking, the accrued liability against the stockholders for final renewals or replacements. "It is the part of wisdom for the owners of properties to reserve from income all that may be required to preserve intact their property investments; but this establishes no reason for deductions for depreciation in connection with rate-fixing."

Training the Outdoor Staff.

A highly suitable subject for the jubilee meeting was furnished by a paper presented by Mr. F. W. Goodenough. It bore the title "Creating an Outdoor Staff." Perhaps, there is no one who from experience, in view of the magnitude and diversity of the operations under his control, is more qualified than the author to deal with this important question. It is a big subject; it is one that presents to us one of the changes that have sprung from the development of our industry, and that calls for an order of workman and salesman as widely separated from the old rule-of-thumb days as the high-power gas-lamps of to-day are from the deposed flat-flame burner. There is general knowledge as to what the Gaslight and Coke Company have done in the matters of training lads from school, and improving the technical knowledge of staff and workmen. But Mr. Goodenough gives a valuable account of the several details. In the author we have a keen critic of the present system of elementary education, which is a lamentable failure in fitting boys for the vocations of life. The material, however, has to be taken that lies at hand; and it rests upon the employers of labour in bulk to do the best possible with the defective foundation supplied by the elementary school. A defective foundation, of course, makes much more difficult the rearing of a strong superstructure; hence the need for thoroughness, in the interests of the employers' concern, in what is done educationally. There is no need to dilate upon the importance to the gas industry of the thorough training of the outdoor and indoor gas supply staff; but few undertakings take the matter so earnestly and completely in hand as the Gaslight and Coke Company. But at the conclusion of the paper (which will serve good stimulative and guiding ends), there is a suggestion for co-operative work to be started among adjoining gas undertakings and county authorities.

It is of the utmost importance that the educational work of the outdoor and indoor gas-supply staffs should proceed simultaneously, so that the good work of the one should not be undone by the other; and this is carried out in the case of the Gaslight Company. The educational work is in the capable hands of Mr. W. H. Y. Webber. There are lectures and demonstrations, with annual examinations; the lecturer being also the examiner. The need of the gas industry is not only for fundamental knowledge, but for continuous information as to advances and fresh discovery. The courses are governed by contemporary requirements, and the deficiency revelations of examinations. To participation in the staff improvement scheme, there are admitted promising showroom attendants, leading gas-fitters, and the older apprentices. Attendance is obligatory upon those of the staff who have not previously been through a course. In the examinations, two grades of papers are set; the lower examinations being designed to test the fitness of aspirants for promotion to staff and to superior non-staff appointments. The men see the advantage of this, as merit takes the place of mere time-service in "getting on." The plan also induces private study. The Company are politic in the matter of encouragement. Money awards and certificates are granted. Encouragement is likewise given to attend the Polytechnic classes. On production of satisfactory evidence that students have made at least 75 per cent. of possible attendances at the Gas Supply classes, the Company refund to the students the whole of the fees paid. Reward is also made to the successful students. The advantage to the Company needs no particularizing. Uniform and up-to-date technical knowledge of work, appliances, and requirements, and sharpened intelligence of staff and workmen, are of paramount importance in the interests of the gas industry. Special attention is also given to the training of gas salesmen, who are not only taught how to sell, but are technically instructed in the construction and proper use of the appliances with which they have to deal. The complete scheme for the practical training of lads as gas-fitters is also described. This work is carried on in co-operation with the London County Council —part training at the Westminster Technical Institute, and part in the Company's workshops and on the district. A six years' course is provided; and the Company pay the lads a progressively rising wage right from the start. There is a careful selection of lads, and there is a fine record in the training result. The Company secure good, intelligent, and attached workers.

Circumstances and Requirements.

The discussion on Mr. Goodenough's paper was the best at this sitting; but it was very clear that the large amount of material the paper contained had not been thoroughly digested by, and its meaning part by part established in the minds of, some of the speakers. This was not due to any ambiguity on the part of the author; for he has the facility of saying things in transparent language. The participants in the discussion were Mr. A. Morton Fyffe, Mr. Ralph Halkett, Mr. J. G. Tooms, Mr. W. R. Herring, Mr. H. Kendrick, and the President, to the last-named of whom so much is due for what has been done in educational work in connection with the Gaslight and Coke Company. There was one thing that was strongly insisted upon by various speakers, and that was that the boys who undergo special training should have had a thoroughly sound elementary education, for without this there is not a good foundation for the technical and commercial training, nor will the boys, when they arrive at man's estate, be fully competent to come into contact with the consumers. Illiteracy brings contempt both upon employers and concern; and men of the kind are inefficient in the matter of presenting proper reports. Mr. Herring has found the raw material of a very unsuitable kind; and there is a feeling that, in the present day, boys and youths such as are required are prone to wastefully spend all their leisure hours. But in the matter of the technical training of boys and men, one difficulty that has to be faced is the non-recognition of their own deficiencies by those whose knowledge it is desired to improve. There is also the view that local conditions—economic and expedient—vary the possibilities in this matter.

However, there is one thing that is essential, and it is that both men and boys must be encouraged. Mr. Fyffe especially was very strong on the point that, if gas undertakings require men of good technical and commercial education in their particular lines of work, they must pay accordingly. Quality must be paid for, as Mr. Herring puts it. Alluding particularly to the training of boys, Mr. Tooms is of opinion that the scheme put forward by Mr. Goodenough is not suitable for small undertakings; but the point is well met by referring to the suggestion of the author that the small undertakings should group themselves and co-operate in conjunction with the geographically placed educational authority. What is done at Waterford in the way of trades preparatory schools was described by Mr. Tooms; but really there is a very narrow difference between this and what Mr. Goodenough describes. Mr. Halkett sketched the broad-minded policy on these questions existing in Glasgow; and he suggests that examinations should be both written and *viva voce*. Mr. Kendrick made a good contribution, interposed in which were some philosophic dicta. One was: "We must divorce gas-fitting from plumbing, and set up a new race of tradesmen." Another was: "Local sentiment must be suppressed for the good of the gas industry." The President evinced his enthusiasm for raising the efficiency of the outdoor staff, and expressed himself as extremely gratified at the way the educational authorities have taken up this matter. It may be mentioned here that later in the meeting, Mr. H. Wade Deacon, J.P., the Chairman of the Liverpool Gas Company, and a member of the Lancashire Educational Committee, mentioned that he is actively concerned in this question, as the members of the latter body are not at the present time satisfied that they are getting results for the expenditure they incur. He firmly believes that Mr. Goodenough's paper will assist in guiding them.

Distribution in a London "Suburb."

The title of the interesting paper—the last on the list—with which Mr. A. A. Johnston, the Engineer of the Brentford Gas Company, supplied the meeting does not do justice to his story. It indicates some limitation. But the only limitation we can find about the contribution is that Mr. Johnston has only had the opportunity of exercising his engineering talents in relieving his own Company of a very difficult situation in regard to the distribution of gas in 50 square miles of territory, partly in London proper, and partly on its borders, while, as a matter of fact, there are generally applicable lessons to be gathered from the modest and plain tale told by the author.

The opening of the paper arrests attention by the information as to the prolific increase in the population in Greater London. People have also been migrating for residential purposes from Inner to Outer London. It is usually forgotten, when considering the enormous growth of gas supply, and at the same time of the electricity supply industry, that the whole of the advance of the latter has not truly been obtained at the immediate expense of the former. The expansion of the population, and the extensions of the manufacturing industries, and of wholesale and retail trading, have all contributed to give the competing industries additional scope for business. Just consider that in the Brentford Company's area the population has increased by 38 per cent.; and the number of families by 43·7 per cent. When we see that the percentage of families supplied with gas is 90·89 per cent.—well, all we can say is that the officers of a company that can show such a percentage as this deserve all they can get in the way of reward. Comparison with the previous decadal figures given present remarkable flights in business connections; and there is no suggestion that the rate of increase in population is going to decline.

The rapid extension of business in the Company's area naturally emphasizes the inadequacy of the distribution plant. Mains were small; and the distance of the works from the larger centres of consumption reduced the effective capacity of the holders during the period of heavy loads. The governors at the Brentford works were also small. The sketch Mr. Johnston gives as to the way in which he set about the remedial work shows that he was of opinion that this was not a case for half-measures. There was a concentration of governors, station meters, and gasholder valves; and there was also duplication of valves. Connections were rearranged; the governor bye-passes being disposed in manner somewhat similar to that employed by Mr. William King when at Liverpool, as described in the paper. A Sturtevant fan driven by a De Laval steam-turbine has also been installed; and this has postponed heavy capital expenditure for some years. The result of the whole work is that complete command has been obtained over the storage and distributing plants. The holder capacity for practical purposes has been nearly doubled; and it is now possible to maintain pressure "to the last rivet." Intercommunication between the Brentford and Southall stations has been established by a new 30-inch main. A very important point is mentioned towards the end of the paper, and that is, in a rapidly growing district, the ever-decreasing proportionate capacity of the distributing-mains to consumers. A wise discretion in extending or enlarging mains may mean a money-saving in the future; for in these days of expensive road reinstatement and congestion of space, an eye must be kept upon probable requirements many years hence. To meet intermittent heavy consumption, Mr. Johnston firmly believes in boosting—adopting the method of "assisting" the gas along by reducing the pressure a little on the inlet side of the booster, and raising it on the outlet or forward side. There are several other useful points in the paper.

A Brief Discussion.

There were only two speakers on the paper, Mr. R. W. Edwards and Mr. Walter Hole, with a complimentary supplement by Mr. Edward Allen. Mr. Edwards recounted somewhat similar experiences at Aldershot; and Mr. Hole asked one or two questions bearing on the point as to whether any trouble is experienced with the compressors on the part of consumers within 300 or 400 yards of them. But as Mr. Johnston says there are no consumers within this distance, the point falls to the ground. Again, the brevity of the discussion (if so it can be called) gives no opportunity for touching upon points of general interest.

The New President, and Liverpool Next Year.

The Scrutineers' report was submitted; and proved the unanimous selection of Mr. Edward Allen as the successor of Sir Corbet Woodall in the presidency. Mr. John Bond moves up into the Senior Vice-Presidency; while Mr. John Young takes the first step to the chair by being elected Junior Vice-President. Each name in turn was received with applause, and there was the same level of enthusiasm when it was heard that the nomination of Mr. W. E. Price as Hon. Secretary had been unanimously endorsed. A warm-hearted reception was accorded Mr. Edward Allen as he rose to acknowledge the honour the members had done him. This he did fervently; and unnecessarily assured the members that, consistent with his duties at Liverpool, the best of his abilities would be devoted to the furtherance of the interests of the Institution, the profession, and the industry generally. It would not be Mr. Allen who would do otherwise. Then the members heard from the President that the Chairman of the Liverpool Gas Company (Mr. H. Wade Deacon) had come specially to London to invite the members to hold their next annual meeting in Liverpool. When Mr. Deacon rose, the manner in which he was received left no room for doubt as to the depth of the appreciation of the members of this act of personal courtesy. It is 35 years since the Institution met in Liverpool; and the kindly and whole-hearted manner in which the invitation was given, left no room for any alternative, even had any single individual contemplated suggesting one.

Honorary Members.

Pleasurable was the duty of adding to the roll of honorary members, the President of the Société Technique du Gaz en France (M. Boutan), the President of the Dutch Association (Heer Bolsius), and the President of the German Association (Herr F. Reese).

Votes of Thanks—National Gas Exhibition.

There was a perfect shower of thanks to wind up the jubilee sittings. The task of the President on this occasion had been responsible and arduous; and there was one word that appositely expressed the feelings of the members at the closing stage—admiration; and that word was used by Mr. R. O. Paterson, in making the charming little speech with which he moved a vote of thanks to Sir Corbet, including a further one to the President and Lady Woodall in anticipation of the hospitality they were showing the members on the day following at Chislehurst. The seconder was Mr. T. Banbury Ball. There was enthusiastic applause; and the President had to wait upon the will of the members before he could voice those thanks that only courtesy on his part, under the circumstances, really dictated. But Sir Corbet had to say that from the opening meeting, the members had made the period one of unqualified pleasure. There was a word, too, for his predecessor in the chair, Mr. R. G. Shadbolt—Sir Corbet feeling that somehow or other they had, during the extraordinary character of the meetings, lost sight of the obligation under which they were to Mr. Shadbolt. There was congratulation also upon the selection of President for the coming year. But the President did not sit down without a word of appeal to those undertakings who have not yet financially supported the National Gas Exhibition. He hopes that the announcement he made at the dinner the previous evening, as to the gracious patronage of their Majesties the King and Queen, would assist in producing a determination to subscribe. He further mentioned that the Institution Council have resolved to set apart £1000 of their funds as a second guarantee for the exhibition, to encourage those who have the matter in hand, though he does not anticipate, if all gas undertakings do their duty, that this sum will be required. At the same time, he reminded of the sums that the Institution receives for special purposes from the funds of the British Commercial Gas Association.

Then the Council, the Hon. Secretary, the Auditors, and last, but by no means least, Mr. Dunn were all cordially thanked; and, with these good feelings dominant, the jubilee sittings, in which there had been so much interesting incident, came to an end.

THE INSTITUTION JUBILEE DINNER.

SIR CORBET WOODALL, D.Sc., M.Inst.C.E., presiding.

THE Jubilee Dinner of the Institution was held on Wednesday evening at the Connaught Rooms. There were close upon 300 acceptances. From seven o'clock until half-past seven the President was, in the ante-room to the banqueting hall, receiving guests and members, with a cheerfulness that did not indicate the slightest physical fatigue after the incessant demands made upon him during the two days of celebration so far spent.

Promptly at 7.30, the guests were invited to the banqueting-hall; and when the President and guests were seated, it was seen how thoroughly representative of the industry's work was the gathering. Apart from members of the Institution and representatives of the Society of British Gas Industries and British Commercial Gas Association, the science of engineering and chemistry, university life, and the parliamentary bar (with which a large statutory industry such as ours is constantly associated), were all in distinguished evidence. There were our gas-engineering friends from over the seas, here to offer their felicitations, and to have part in the festivities. It was impossible to see whether all whose names were inscribed on the plan of the tables were present. But so far as could be traced, there were few absentees; and it may therefore be taken that approximately correct is the following list of those who were placed to the right and left of Sir Corbet at the top table.

To the Right-Hand Side of the President.	To the Left-Hand Side of the President.
Mr. R. Elliott-Cooper (*President of the Institution of Civil Engineers*).	Sir Alfred Keogh, K.C.B (*Rector, Imperial College of Science and Technology*).
Sir Ryland Adkins, M.P.	M. R. Ellissen (*French Society of Gas Engineers*).
Mr. Ernst Körting (*German Association of Gas and Water Engineers*).	Sir H. Frederick Donaldson, K.C.B. (*President, Institution of Mechanical Engineers*).
Mr. Albert Gray, K.C.	Heer P. Bolsius (*President, Dutch Association of Gas Engineers*).
Mr. William King.	Mr. Arthur Cooper, LL.D. (*President, Iron and Steel Institute*).
Mr. J. H. Balfour-Browne, K.C.	Mr. E. Honoratus Lloyd, K.C.
Dr. Marston Taylor Bogert (*President, Society of Chemical Industry*).	Mr. Thomas Newbigging, D.Sc.
Prof. Silvanus P. Thompson, F.R.S. (*President, Illuminating Engineering Society*).	Prof. Harold B. Dixon, F.R.S. (*President of the Society of British Gas Industries*).
Mr. W. D. Helps (*Chairman of Council, Society of British Gas Industries*).	Mr. E. L. Rieha (*American Gas Institute*).
Prof. Arthur Smithells, F.R.S.	Mr. Vesey Knox, K.C.
Mr. A. G. Vernon Harcourt, F.R.S.	Bailie Paxton, of Glasgow (*British Commercial Gas Association*).
Mr. C. V. Boys, F.R.S.	Dr. Arthur H. Elliott (*American Gas Institute*).
Dr. J. Bueb (*German Association of Gas and Water Engineers*).	Heer L. Sauter (*Dutch Association of Gas Engineers*).
Heer K. N. Geerling (*Dutch Association of Gas Engineers*).	Mr. A. F. P. Hayman (*Belgian Association of Gas Engineers*).
Prof. John W. Cobb, B.Sc. (*Livesey Professor of Coal Gas and Fuel Industries*).	Mr. E. B. Ellington.
Mr. S. E. Figgis (*Past-President, Victorian Gas Managers' Association*).	Heer O. S. Knottnerus (*Dutch Association of Gas Engineers*).
Heer D. Bisschop (*Dutch Association of Gas Engineers*).	Mr. G. Crispe Whiteley.
	Heer L. J. Terneden (*Dutch Association of Gas Engineers*).

The vice-chairs were occupied by:

Mr. Sydney Y. Shoubridge (table B), Mr. Alexander Wilson (table C) Mr. Thomas Glover (table D), Mr. Charles Wood (table E), Mr. Edward Allen (centre table F), Mr. John Bond (table G), Mr. W. Doig Gibb (table H), Mr. J. W. Helps (table I), Mr. Robert G. Shadbolt (table J).

Among others present were Professor W. A. Bone, F.R.S., Mr. Charles Hawksley, Mr. J. V. Irminger (Copenhagen), and Mr. R. M. Searle.

The front of the souvenir menu card was of very artistic and appropriate design—it being the work of Mr. F. D. Marshall, whom the President thanked towards the close of the evening. We give a reproduction on a slightly smaller scale; the original being 7 in. by 8½ in.

During the dinner, there was music by the Imperial Band; and later, between the speeches accompanying the toasts, there was some excellently rendered vocal music.

NATIONAL GAS EXHIBITION—THE PATRONAGE OF THEIR MAJESTIES THE KING AND QUEEN.

The loyal toasts having been honoured,

The PRESIDENT had an important communication to make. He said: We have drunk those toasts as Englishmen and British citizens, wherever they gather, at home or round the wide world, drink them, as a testimony of our loyalty to the Throne, and of our respectful love for those who occupy it. I should have been sorry to have added to the toasts any word more than the mere mention of the names of those we respect and love so much; but now I may make an announcement, which I do with very great pleasure. It shows that, while the King and Queen have so many duties to perform—arduous duties many of them—they are yet able to give attention to matters, to them of comparatively small import, to us in this case of very great import. My announcement is that the King and Queen have been graciously pleased to become patrons of the National Gas Exhibition which is to be opened in the month of October. [Applause.]

"SCIENTIFIC EDUCATION."

Dr. MARSTON TAYLOR BOGERT (President of the Society of Chemical Industry) proposed the toast of "Scientific Education." He expressed his gratitude for the privilege of being present at this Jubilee celebration; and he brought to the President and members of the Institution of Gas Engineers not only the greetings of the Society of Chemical Industry but of the American Chemical Society. The toast was an exceedingly pleasant one for the Professor of a University to propose—"Scientific Education," which had been dear to him for many years. He was glad of the opportunity of pointing out something which he thought was of the utmost importance at the present time. This was the necessity for close co-operation between the Universities, on the one hand, and those who represented such important branches of industry as those who were now celebrating the Jubilee of their Institution. The only way, indeed, in which there could be real progress was by co-operation between the two important factors. This was not only nationally true, but it was true of the individual concern—the concern that made the greatest strides and advancement was the one that had put into it the largest amount of brains. The requirement of the gas industry was to get the maximum amount of produce for the expenditure of the minimum amount of raw material, and that could only be done by the aid of science. The one natural resource which increased for ever, and must be commercially used, was human intelligence; and the cultivation of this was the one substantial basis of the prosperity, the progress, and the happiness of any nation.

Sir ALFRED KEOGH, K.C.B. (Rector of the Imperial College of Science and Technology), attributed his naming to respond to the toast to the fact that he happened to be the administrative head of a great scientific college in London. There were, however, professors of the college there who could tell them much more about its operations; but he supposed they would prefer that he should respond. He had no doubt there were many gentlemen there that night (of course, he did not include those many distinguished men from foreign lands who were present) who had not even heard of the Imperial College. He was glad the proposer of the toast alluded to the relation between scientific education and the industries of the country, as it gave him an opportunity of mentioning that the Imperial College was the outcome of the union of three colleges expressly for helping to bring about the co-operation between science and industry. He thought it was necessary that everybody who had connection with industry should know that they had in London something which many foreign countries possessed—a great institution definitely intended for training in the highest sense a young man for the industries of the country. At the Imperial College, a very definite policy had been established. They did not profess to train young men until they had had first of all a very sound scientific education either at South Kensington or elsewhere. All the work—the work of which they were proudest—was post-graduate work; and they believed that, if the young men had talent, they should be encouraged to research. They believed their education, if they had obtained their degrees, should be in the laboratories. It was not their intention to teach them definite industrial work; and they recognized, of course, that, when these young men went to the industry with which they were to become associated, they were only half educated, and their education had then to be

carried on on other lines. There were at the present time nearly 1000 students in the College. They were not more seriously minded than any other class of boys, and he did not know that he particularly wanted them to be. But they were among the most industrious, hard-working, and enthusiastic young men of the country. Their conduct was as those present would wish it to be; and their industry was extraordinary. He believed, too, the splendid staff the College had obtained was worthy the objects of the Institution. The question of education was much in the air at present. They were promised a Government Bill, dealing with education; and there had been a report on the reorganization of the University of London. He did not think either of these would improve the system of education which was given at the Imperial College, because the system was guided by the industries of the country. The governors were nearly all derived from the industries; and as long as the College was guided by them, they would keep on the lines which those before him would, he was sure, like to see followed.

Professor Arthur Smithells, F.R.S., who was enthusiastically received, said he desired to associate himself most cordially with the words of acknowledgment that had fallen from Sir Alfred Keogh. In the past—he did not know on how many occasions—he (Professor Smithells) had lectured the British gas industry on the subject of scientific education; and the members

PHOTOGRAPH OF THE FRONTISPIECE OF THE SOUVENIR MENU CARD,

Designed and Drawn by Mr. F. D. Marshall.

[Reduced from 7 in. wide by 8½ in. deep.]

of the industry had borne it with the utmost fortitude. [Laughter.] He did not promise that he should not in the future lecture the industry again; but on one thing he was firmly resolved—that he would not lecture the members of it that evening. He felt that he owed them a large debt of silence, which he would faithfully repay on this occasion. In a sentence, he would only acknowledge the great compliment paid to scientific education by its recognition on this eventful occasion, and by the honourable place it had been assigned on the toast list. The gas industry had been fully alive to the importance of scientific education in relation to their industry. No one could be more keen to recognize this—no one could recognize it more gratefully—than himself and the institution with which he was connected. In its great generosity and confidence, the gas industry had established at the University of Leeds a professorship especially intended to minister to the needs of the industry. He could only say, as he had said before, in the name of the University, that they intended to make the Chair worthy of its founders, and worthy of the great name that was in its title. They were extremely grateful, on behalf of those connected with scientific education, for the compliment that had been paid to them that evening; and he took this opportunity of returning his own personal thanks to the members of the gas industry for the great kindness and courtesy he had always received at their hands.

"The Institution of Gas Engineers."

Mr. J. H. Balfour Browne, K.C., said he had great pleasure in proposing the toast of "The Institution of Gas Engineers." Such an Institution was essential in these times for the prosperity and welfare of a profession. It was only through the voice of such an Institution as this that those present, as a profession, could make their voice heard, understood, and appreciated by the Public, the Press, or by Parliament. It was no longer true that "Truth is great and must prevail," if the truth was only in the whisper of the individual conscience. But truth, if backed by a great battalion, could make itself appreciated and respected. He took it that it was because of this that the profession of gas engineering, as other professions, found it absolutely necessary to secure conjoint action; and he took it that the Institution existed not for the purpose of hospitality such as they were enjoying that night, but for the protection of its members, for the furtherance of its objects, and the safeguarding of its interests. The maxim of some time ago "Early to bed, and early to rise," &c., had been amended to "Early to bed and early to rise are no use unless you advertise." He would propose another amendment, "Early to bed and early to rise are no use unless you organize." [Laughter.] It was quite true that the publicity given by advertisement was essential to the success of a man or of soap in these modern days. They must put their candle on a tall candlestick, and not allow it to be smothered under a bushel. It was necessary to unite, in order to succeed in their aims, in such a society as this. But it was not altogether good. There was another aspect of this question. They had the caucus in elections, parties in politics, unions in labour, and trusts and combines in commerce and in industry. Collectivism was a valuable instrument for certain purposes, but it was apt to put an end to individual initiative, personal enterprise, and originality, as well as responsibility and conscientiousness. A man in such a society was very much reduced to the position of a unit in the mass. And there was something to be said against the drill sergeant. The strict rules of societies, sects, and parties had reduced the personal initiative of men and the personal responsibility of individuals. He deprecated this, for instead of gold it gave them silver; they asked for bread, and received a stone. He had said his best and his worst for such a society as this. But there was value in unity for general purposes. He had been tempted upon this line of thought because there was one who was decorating this Institution by his presidentship, who had been a member for a great number of years, and who had maintained throughout his sterling individuality. It was because he had had to couple with this toast the name of Sir Corbet Woodall that he had ventured upon these observations. The tendency of society to collectivism, to reduce individual action, had had no influence upon him. He had known Sir Corbet for a great number of years. He had known, and he had seen, how he had preserved his individuality. He had not regulated his conduct by the by-laws of this or any other Institution; he had been actuated by the dictates of conscience. If he (Mr. Balfour Browne) had one complaint to make of Sir Corbet, it was that he had sometimes too much conscience to play the part of an expert witness. [Laughter.] It was because he recognized, as everyone who knew Sir Corbet recognized, his sterling worth that he gave the toast of the "Institution of Gas Engineers," coupled with the name of the President. [Cheers.]

A Calorific Standard.

The President, in reply, said they had had, during the past two days, a great deal of talk regarding the Institution of Gas Engineers and the industry of gas supply; and he had no desire here to add to what had been said, especially concerning their industry. As to the toast, he must say that it was a pleasure, and he was bound to say generally a profit to him, to be in agreement with Mr. Balfour Browne. [Laughter.] When they were on the same side, he (Sir Corbet) had always a profound belief in his sagacity, and confidence in his judgment, and he readily followed him. But while agreeing with much that he had said that night, he should be glad could he have him (Mr. Browne) present at one of the meetings of the Institution, in order that he might judge whether or not the individuality of the members was absorbed in the Council or in any body except the individual himself. ["Hear, hear."] They were a scientific society; and they valued very greatly the presence of so many distinguished scientists at their table. They had been hearing that evening about scientific teaching. Among the members of the Institution there was a very general feeling that it was a good thing to combine with the work in which a man was engaged the study at the same time of such science as would help him on his way. He (the Speaker) would not try to elucidate the matter now; but he should like to see men who were to become leaders in their industry take their training very much as the boys who were now being educated in their establishments to become fitters and competent workmen among the consumers. He thought that one of the most helpful uses to which these annual gatherings were devoted was the assembling together of men who were usually scattered by their vocation all over—not simply Great Britain, but also the distant parts of the world. That day, as all present knew, the members were keeping the Jubilee of the Institution; and they had with them gentlemen from many distant places. Even since they had been assembled in the room he had received from the Swiss Association of Gas Engineers—in addition to the many messages of goodwill and brotherhood they had already had from the Continent and America—hearty congratulations, and good wishes for a full success in the future work of their British colleagues. He thought all present were agreed that their gathering during the week had been made infinitely more helpful than it could otherwise have been by the presence with them of distinguished members of the profession from abroad. Turning for a moment to the question of gas supply to-day, it was a remarkable fact that, in London at any rate, the manufacture was carried on, not to meet the needs of the gas consuming public but in order to manufacture gas for testing according to the prescriptions of their friend Professor Boys and his colleagues. They had a standard of illuminating power, which was now of no value—at all events of no consequence, except to the gentlemen who were engaged, in many stations scattered over London, in testing laboriously and efficiently, from morning to night, the quality of the gas supplied. Except the gas these gentlemen burned at the testing-stations, practically nobody else used gas for the sake of its luminosity. The luminous gas-flame was to-day hardly known; yet the whole industry, at any rate in London, was carried on for the purpose of making a luminous gas which nobody wanted. Now that 90 to 95 per cent. of the gas was used for purposes in which its luminosity was of no consequence, and the heating value was everything, the time had come for the abolition of the illuminating power test altogether; and he hoped that next session would see some important movement to this end, and the substitution for the old standard of a more rational one. In conclusion, he desired to thank the members for all the support and countenance they had given him during the past two days. He trusted the meeting would conclude as happily as it had begun. And when, by-and-by, a gathering was held to commemorate the Centenary of the Institution of Gas Engineers, he trusted it would be under circumstances as promising and as favourable as those under which they were met together that night. [Applause.]

"Kindred Societies."

Mr. Edward Allen, in proposing the toast of "Kindred Societies," said they were honoured by representatives of many such societies. They had taken bread and salt with them that night; and he took this to represent the spirit of brotherhood and harmony. This spirit they believed would ever continue between them. They were all united in the pursuit of knowledge; and in the work of bettering the conditions of humanity. They were all united because they needed each other; and no one organ or part could say to the other: "I have no need of thee." They were successful in doing a great work that England, the Empire, and the world required, because of this union of their forces. They were pleased to have with them the representatives of the societies that had associated themselves in their Jubilee celebration. The Institution were proud of the past history of the industry; and they looked forward with great hope for the future. The kindred societies were represented there very ably by, among others, Mr. R. Elliott Cooper, the President of the Institution of Civil Engineers, who would respond to the toast which he (Mr. Allen) cordially proposed.

Mr. R. Elliott Cooper, in the course of his reply, said he imagined the only reason he had been asked to respond to the toast was that he happened to be this year the President of the Institution of Civil Engineers, with which Institution so many distinguished members of the Institution of Gas Engineers had been and were connected. In fact, it was only necessary to look at the beautiful frontispiece of their menu card to see the portrait of that great Civil Engineer, Mr. Thomas Hawksley, who was the first President of the Institution of Gas Engineers fifty years ago; and it was also interesting to know that Sir Corbet Woodall occupied such a high position, not only in the Institution of Gas Engineers, but in that which he would call the Parent Institution—the Institution of Civil Engineers. Mr. Cooper then traced the history of the formation of the Institution of Civil Engineers, and the necessity that subsequently arose for the formation of organizations representing the separate interests of engineering. But he was glad to say that, though there were a great many of what he might call independent engineering bodies now existing, they were allied to the Parent Institution. While he was speaking of these institutions that were closely allied to the Institution of Gas Engineers through engineering, he must not forget those kindred societies not so closely allied, but which formed an important addition to this Institution. There were, for instance, the chemical societies. There they had most important bodies with which the gas industry was closely and commercially allied. Then they had with them distinguished members of foreign gas societies; and he was sure it must be a great pleasure to them to be there that evening, and to the members of the Institution to extend their hospitality to them. Referring to scientific education, he mentioned that the Institution of Civil Engineers had now established a system of examinations, without the passing of which it was impossible for any young engineer to enter the ranks of the Institution. On behalf of all kindred societies, he thanked those present heartily for the toast.

"Our Brethren over the Seas."

Mr. William King, in proposing this toast, remarked that on this historic occasion, they recalled how many of them had had

collective and individual experience of the kindness and hospitality of their friends across the sea. He recalled visits to Germany, to France, and to Copenhagen, where boundless hospitality had been shown to members of the Institution. From personal experience he could assure the members that wherever they went, they would find the gasholder a bond of union. Wherever they saw a gasholder, they knew that there must be a man in charge, and from him they would receive the greatest kindness—not only with regard to professional advice and information, but also with regard to social hospitality and those kindnesses which were so dear to the solitary traveller. This applied to distant places as well as to places nearer home. Good feeling and fellowship prevailed everywhere. That night they remembered not only their brethren who were with them from across the seas, but those across the seas who were not with them—not only men in the great cities and towns, but men in smaller places and in remote and isolated places. He coupled with the toast the names of M. Ellissen, of the Société Technique, Heer Bolsius, of the Dutch Association, and Dr. Elliott, of the American Gas Institute.

M. Robert Ellissen (Société Technique), replying to the toast, said it was a great honour for him to be present to represent the "Société Technique de l'Industrie du Gaz en France," and to bring his President's excuses, as well as those of his colleagues who were retained at Toulouse for their annual meeting. It was equally a great personal pleasure for him to be able to thank Sir Corbet Woodall for his great kindness. As Mr. William King had just said, he did not wish to consider himself quite a stranger in the learned Society of which they were celebrating the Jubilee. When, in 1888, his father induced his French colleagues to cross the Channel for the first time to compliment them on their silver wedding, he brought with him twenty-five years of grateful remembrance, and remarked that when, in 1864, he was called to London to co-operate in studying the sulphur question, he had the good fortune of assisting at the birth of the Society. Naturally, then, it was particularly agreeable for him (the speaker), as the son of one of their oldest friends, who had for a long time been included among their honorary members, to express his cordial feelings. But that which was agreeable was not always easy. His knowledge of the English language, added to his emotion, did not permit him to express his thoughts as he would have wished. He therefore thought it would be better for his hearers and for himself if he continued his speech in his own language. Proceeding to speak in French, he said he was truly moved in speaking thus for the first time in the midst of an assembly to which he was attached by so many reminiscences. But he desired earnestly to thank Mr. William King for the opportunity he had given him of saying how much they had all appreciated the delicate hospitality shown to them, which was traditional in this country, and was, for Frenchmen, one of the charms of England. He asked to be forgiven if he could not resist mentioning that, in his earliest years, when his father wished to train him in the French works of the Imperial Continental Gas Association, he often met Englishmen, and even then he was charmed by their science, mingled with their affability and charm; and he was not sure that it was not to these early impressions that he owed the largest and best part of his career in the gas industry. Later on, attracted by the technical perfection of their methods, he sometimes had the satisfaction of visiting English works; but these visits were always too short for him. The first of them, made nearly fifteen years ago, gave him the opportunity of studying the first water-gas installation at Manchester. The last, made but a few months since, was prompted by a desire to study the installations for continuous carbonization in vertical retorts in London, Birmingham, and Smethwick. It would be seen, from these two examples, that he did not have to wait for the honour of knowing the President personally before he could admire and applaud the work of English engineers. There was always much that could be learnt in their midst. Already the Société Technique had been modelled on the Institution. The principal French gas companies had followed the examples of those in England; and if they found prosperity attending the large gas organizations, such as that which he had the honour of directing, they owed it to the experience of the Imperial Continental Gas Association and the Continental Union and European Gas Companies—their beloved sisters, who were always friendly, always sympathetic to a high degree, and with whom he felt honoured to stand on such close relations as he did. If, in speaking thus of the ties which united the gas companies of the two countries, the words "*entente cordiale*" were nearly falling from his lips, he would not make use of them; he recoiled from the solemnity of the expression, which would soon be greeted in their city by the sacred refrains of the two National Anthems. He would conclude simply by raising his glass to their fraternal affection; to their comradeship, which was already half-a-century old; and to the sentiments which inspired their two families of gas engineers, and all families of gas engineers represented there, who, like himself, had the honour of taking part in these Jubilee celebrations, to which that evening the presidency of Sir Corbet Woodall imparted additional dignity.

Heer P. Bolsius (President of the Dutch Association) asked to be allowed, in the name of the Dutch Association of Gas Engineers, to offer his sincere congratulations to the Institution, and to say how much the Council and members participated in the joy of, and associated themselves with, the jubilating glory of the Institution. They were not the last to conceive the importance of the fact that during half-a-century their English colleagues aimed, in fraternity and mutual stimulation and emulation, to further the growth and prosperity of the gas industry at home and abroad. This fruitful collaboration had turned to the greater profit of what they might call with pride one of the most excellent factors in the modern formula of public weal and wealth. This being so, their wishes and felicitations were at the same time thanksgivings, not only to the present members of the Institution, but to the memory and merits of all the pioneers and workers who long ago, by strong and indefatigable labour, prepared the arduous and successful ascension of the gas industry to victory and to mightiness. The English gas industry, it might be pointed out, had, best of all, maintained the real industrial character; and this alone merited their greatest gratitude. He concluded by expressing the hope that the Institution of Gas Engineers might keep alive and guard the divine flame of energy and progress, and that this flame might for a long time find a solid shelter beneath the monumental cupola built under the rules of the organization, as a modern symbolical Temple of Vesta. He drank, in the name of the Dutch Association of Gas Engineers, to the prosperity of the Institution of Gas Engineers and the health of the President, Council, and members.

Dr. A. H. Elliott (American Gas Institute) said this was one of the red-letter days of his life. He stood there representing (according to the toast list) Dr. Hans Bunte, and Mr. Walter R. Addicks, the President of the American Gas Institute, and Vice-President of the Consolidated Gas Company of New York; and yet he was an English boy born and bred. [Applause.] He had the honour of combining in his life a scientific training in the Royal School of Mines of England, and practical knowledge both at Manchester and under Mr. W. H. Bradley, the Chief Engineer of the Consolidated Gas Company of New York—the Nestor of the gas industry in the United States. The American Gas Institute had not the prestige that the British Institution of Gas Engineers had, but the members were a pretty lively set of men. They were trying to work out on the other side very similar problems to those engaging attention in Great Britain. They were trying to make gas in New York City for 80 c. per 1000 cubic feet, and everybody was kicking. They were trying to make gas for 80 c. per 1000 cubic feet; and coal was rising, and oil was going up in price like a sky rocket. They were trying to make gas in New York City for 80 c. with a Public Service Commission behind them, who told them they were to keep their books in a certain way, and must not make more than 6 per cent. dividend. He brought to the Institution of Gas Engineers the hearty greetings of the American Gas Institute. He was also a member of the Society of Chemical Industry, of which Dr. Bogert was the President; and he was one of the members of the American Chemical Society; and they were all working to one end. He was proud to be there that night; and his only regret was that Mr. Addicks was not there to respond for himself. Mr. Addicks had had a fight during the past winter for just what they were fighting for in this country—the supersession of photometry by calorimetry; and the Governor of the State of New York had signed a Bill allowing a calorific standard instead of an illuminating power one. This was a step in the right direction; for he believed that at least 90 per cent. of the gas in New York City was used for its heating merits and not for its illuminating power.

Society of British Gas Industries, and the British Commercial Gas Association.

Mr. John Young, in proposing this composite toast, mentioned how the gas industry had benefited by the valuable work of the two organizations. The members of the Society of British Gas Industries had rendered great assistance in the perfecting of the appliances used in the manufacture and utilization of gas for domestic and industrial purposes. What they had done had earned the admiration of gas engineers. When the Society was first formed, some of them wondered what it was going to result in. It was viewed by certain of them with feelings akin to dismay; but he was proud to think that he was one of those who took a hopeful view. Subsequent events had proved that the hopeful view was the right one. The good work of the individual had been enhanced by the collective work of the Society. They had shown, in a very material manner, their desire to further the interests of the gas industry, and that in a whole-hearted way. The British Commercial Gas Association had also done valuable work; and through it the Institution of Gas Engineers and the Society of British Gas Industries had come to know each other better. He associated with the toast the names of Professor Harold Dixon, the President of the Society of British Gas Industries, and of Bailie Paxton, a member of the General Committee of the British Commercial Gas Association.

Professor Harold B. Dixon, F.R.S., made a racy little speech in reply; and, in the course of it, he said that they had heard much about co-operation. But might he say on behalf of the Society he represented that co-operation was not the same thing as amalgamation. However, he hoped that nothing would jeopardize the friendship that the Society had with the Institution.

Bailie Paxton, speaking on behalf of the British Commercial

Gas Association, remarked that it was only some eighteen months ago that the organization was launched; and ever since it had gone on progressing. At a meeting held in London quite recently, they were told that they had now contributors to the Association to the extent of 68 per cent. of the gas supply in Great Britain and Ireland. This was extraordinarily satisfying. In the city from which he came, they were very fond of leading; they did not like to follow. [Laughter.] The City Council were an enthusiastic band. They had 113 members; and six months ago they carried, without a single dissentient, a proposal to pay the full contribution—2s. 6d. per million cubic feet—to the Association. [Cheers.] How any undertaking could participate in the good that was being done through that body, without contributing to the expenses, he could not imagine. He complimented Mr. Goodenough on his work, and described him as the prince of organizers. Further he believed that in a very short time they would have not only 68 per cent. of the gas supply contributing to the Association, but 100 per cent. Every undertaking was wanted as a contributor, for the organization had a great work beforeit.

"The Visitors,"

Mr. Alexander Wilson proposed "The Visitors;" and in doing so, remarked how pleased they were to see so many rejoicing with them in their jubilee celebrations.

Mr. Honoratus Lloyd, K.C., in replying, remarked that he doubted whether he was there as a visitor; for he saw all around him faces that he was accustomed to meet elsewhere day by day.

A Gas Referee and Calorific Power.

Professor C. V. Boys, F.R.S., also responded. In doing so, he referred to the wasteful way in which gas companies had to exert themselves to keep up the illuminating power of gas that nobody wanted; and, in doing so, he disclaimed any connection or responsibility for the conditions as they exist. It was his duty as one of the Metropolitan Gas Referees to do what was necessary under the instructions or directions of an Act of Parliament with respect to illuminating power as to the other qualities of gas. His own personal feelings as to what was right, or what was necessary, had nothing to do with it. As to what he thought, he might perhaps allude to an occasion about three weeks since when Mr. Doherty, of New York, was over here making a proposition as to the treatment of coal gas in order to obtain from it motor spirit. But there were two problems facing gas engineers before they could extract the benzol economically. There was the engineering problem, which every gentleman present would know how to solve; and the other was to educate Parliamentary Committees as to what was the proportionate value of the stripped gas. Parliamentary Committees were a little bit suspicious that any proposition of this kind had some mischief behind it. But let them persuade these gentlemen that it was for the general good, and it would not be long before something would result. In "The Times" it had been stated that this proposition of Mr. Doherty was doomed to failure, because someone had found that, when he scrubbed the gas, it would not give any light at all. The answer he should make to this statement was that, far from proving the proposition was doomed hopelessly to failure, it was the best possible indication that they could have that it was a process that could be carried through successfully. As to the value of the gas, it was obvious to anyone who knew anything about the subject that the only really scientific and absolute test of the value of gas was the calorific one. But he would urge this, that if they were going to have a calorific test let it be the gross figure. It was thought by some that there was something more scientific in the net test. It was more complicated; but being more complicated did not make it more true. The only real test which was a measure of what they had was the gross test, and that ought to be urged most strenuously in Parliament. To his mind, this point should not have been allowed to pass when the test was introduced in London.

Shortly afterwards—the midnight hour was approaching—the National Anthem was sung, farewells were said, and a memorable event in the Jubilee celebrations ended.

GARDEN PARTY AT CHISLEHURST.

Photo. by Chas. R. Watson, Sydenham, S.E.

THE LONG DRIVE LEADING TO SIR CORBET AND LADY WOODALL'S HOME.

If everything could be ordered as human fancy dictates, we are sure the result would not be complete satisfaction. But certainly if the members of the Institution, their wives, fiancées, or other lady friends could have ordered sunshine in the place of lowering skies on Friday morning and intermittent rainfall in the afternoon, badly as Mother Earth was crying for the latter, they would have done so. Sunshine had been prevalent throughout the week until that day, and then came the temporary but inconvenient break. This was regretted more than anything else on account of Sir Corbet and Lady Woodall, who, with the members of their family, had expended a large amount of thought on the preparations, and had made generous provision, for the garden party, to which they had invited the members of the Institution and their ladies, at their residence "Walden," nestling in beautiful and picturesque surroundings at charming Chislehurst—one of the several gemsamong the "works of art" of Dame Nature that are to be found in Kent. However, lowering skies and possible showers were no deterrent to a loyal fulfilment of the acceptance of the invitation kindly extended by the President and Lady Woodall.

Three special trains were required to convey the guests from Charing Cross station to Chislehurst or Elmstead Park stations; for there had been no less than approximately 700 acceptances. On arrival at one or other of the destinations, the visitors found at each numerous motor cars and pair-horse carriages waiting to take them to "Walden;" and the conveyances were for some time kept busy passing to and from the house for the transfer of guests. It was a splendid arrangement, for if the visitors had arrived at "Walden" *en masse*, there would have been an

uncomfortable congestion at the reception. As it was, the conditions contributed to convenience, for the motor cars and carriages entered the iron gates of the estate, and up the long drive to the picturesque house (all of which, save one wing, can only boast of a ground floor), in well-divided succession, and so there was little delay in alighting at the main entrance to the house, in passing through the hall and pretty corridor leading to the principal drawing-room, where stood Sir Corbet and Lady Woodall—the same kindly face that we knew many years ago beaming with the delight that she felt at the pleasure of her husband and so many of his numerous friends. For each visitor there was a cordial handshake and a word of welcome from both host and hostess. Lightening the duties of her mother at the reception was Miss Woodall—as ever, affable and graceful.

The visitors passed from the drawing-room to the lawns, and everywhere the eyes roamed a picture met them; for if Sir Corbet will not tolerate the house being called a "mansion," the 22 acres or thereabouts that the estate comprises, with its open and cultivated spaces, and wooded and pathed surroundings (in which one unacquainted with the place could almost lose himself or herself for a space), are a meet accompaniment for one. Everything looked at its best—the verdant and well-trimmed lawns, the trees in their full springtime dress, the flowered beds, the climbing roses; and centred in it all the old-world looking house with, around, its fine old flagstone paths. Here, indeed, one finds complete retreat from the outer world, with its incessant bustle and noise, and its picturesqueness spoilt by an imposing similarity.

Outside the drawing-room, one was stopped by a small maiden—one of several daintily-dressed little girls and boys, grandchildren of the President and Lady Woodall, who were busily engaged handing programmes to the numerous guests; and in the excitement of the occasion, sometimes two programmes, instead of one, found their way into the possession of the visitor. The little maiden in handing out two programmes to one visitor, in a confidential way, informed him that there was a concert proceeding in a marquee down among the trees; that tea, strawberries and cream, ices, and other delicacies, were being served in the other marquee on the farther side of the large lawn. The visitor thanked his little informant, and away she went to hand out the programmes and impart her information elsewhere. Consulting one of the programmes, it was seen that it was Dodwell's Red Imperial Band that was at the moment giving a splendid rendering of Ivan Caryll's "Oh! Oh! Delphine."

The scene was fast growing an animated one; and, wandering about, one found that the whole of Sir Corbet and Lady Woodall's family were there rendering easy the delightful task of their parents in entertaining visitors. There were, in addition to Miss Woodall and Mrs. Knight, Mr. and Mrs. Corbett W. Woodall, Mr. and Mrs. Henry Woodall, Mr. and Mrs. Harold Woodall, Mr. and Mrs. J. C. Woodall, Mr. and Mrs. Figgis, Mr. and Mrs. De Quincey, and Mr. and Mrs. Margetson. They were all here, there, and everywhere directing, escorting, conversing, and making each and all the guests as happy as was possible—so much so that during the occasional showers, and refuge in the marquees, one almost forgot that rain is not conducive to the maximum enjoyment of a garden party. Noticed among the visitors were Sir D. Ford Goddard M.P., Mr. Balfour Browne, K.C., Mr. Charles Hawksley, M.Inst.C.E.,

Photo. by Chas. R. Watson, Sydenham, S.E.

SIR CORBET AND LADY WOODALL, TAKEN IMMEDIATELY AFTER THE RECEPTION.

Photo. by Chas. R. Watson, Sydenham, S.E.

GUESTS ARRIVING FOR THE RECEPTION.

Photo. by Chas. R. Watson, Sydenham, S.E.

SCENES AT THE GARDEN PARTY

and Mr. W. B. Bryan, Chief Engineer of the Metropolitan Water Board. The Institution's visitors from abroad were among the guests.

All regretted the occasional rain, but what was more important all thoroughly enjoyed the hospitality and pleasure that the President and Lady Woodall had meant should be theirs. The first return special train to town was timed to leave at 6.40; and about six o'clock, adieus having been

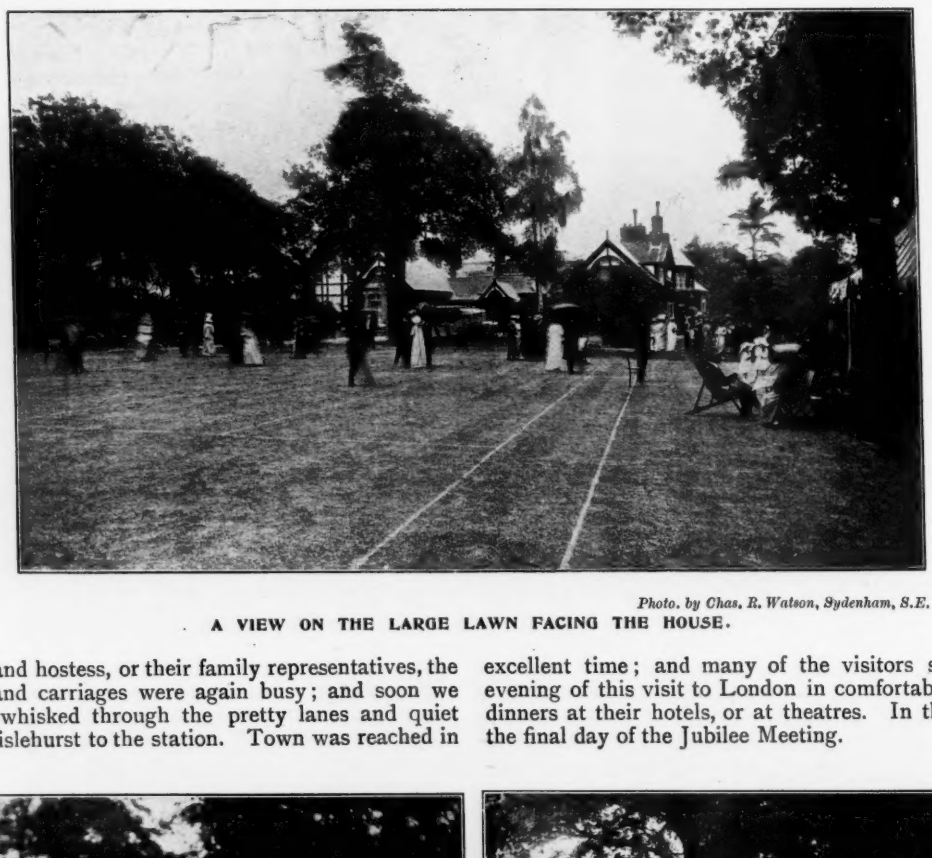


Photo. by Chas. R. Watson, Sydenham, S.E.

A VIEW ON THE LARGE LAWN FACING THE HOUSE.

said to host and hostess, or their family representatives, the motor cars and carriages were again busy; and soon we were being whisked through the pretty lanes and quiet streets of Chislehurst to the station. Town was reached in excellent time; and many of the visitors spent the last evening of this visit to London in comfortable little party dinners at their hotels, or at theatres. In this way ended the final day of the Jubilee Meeting.

Photo. by Chas. R. Watson, Sydenham, S.E.

SCENES AT THE GARDEN PARTY.

GENERAL REPORT.

THE Annual General Meeting of the Institution opened last Tuesday, at the Caxton Hall, Westminster, S.W.—Sir CORBET WOODALL, D.Sc., M.Inst.C.E., the Governor of the Gaslight and Coke Company, the President, in the chair.

Confirmation of the Minutes.

It having been moved and seconded that the minutes of the last annual meeting should be taken as read and adopted, the President signed them.

Appointment of Scrutineers.

On the motion of the PRESIDENT, seconded by Mr. J. FERGUSON BELL (Derby), Mr. J. H. BREARLEY (Longwood) and Mr. H. LEES (Hexham) were appointed Scrutineers.

Welcome of Delegates from Kindred Societies.

The PRESIDENT: Gentlemen, before we proceed with the ordinary business, it is my duty and pleasure to offer a few words of welcome to our visitors, both British and foreign. I shall have an opportunity of referring to their presence with us later on, so that my words now will be very few. We are all charmed to have so many distinguished men with us to-day to share in our rejoicings over the episode we commemorate. Among the British visitors are the leading Presidents and representatives of many of the older and (shall I say?) more distinguished societies connected with engineering, to some of which we have been greatly indebted for their hospitality—for we are a houseless Society at present; and I should also wish to thank them all for their hearty help whenever that has been needed. To our foreign friends, we accord an especially hearty greeting. I think these occasions, which bring to us representatives from foreign States, are peculiarly valuable to ourselves; and they are also typical of the advantage that attaches to the nations which in a measure they may be said to represent. It is an extremely good thing, considering that it is a very far cry from the United States to Westminster, that so many of our American brethren have crossed the sea to come to us. We have also a representative from the Société Technique du Gaz en France. [Applause.] That Society is, unfortunately for us, holding its meetings in Toulouse at the same time that we are holding ours; and, consequently, is it impossible, as the President wrote me in an extremely charming letter, for him to be present with other members. But, with the courtesy which comes naturally to the nation, they have deputed M. Ellissen to be their representative here; and, to our great satisfaction, M. Ellissen has kindly consented to sever himself from his brethren, in order that he may fulfil the mandate of the Council. [Applause.] Then we have representatives from Belgium and Holland—representing Societies which have repeatedly shown us great courtesy when we have been in their countries; and we have, also, three distinguished representatives of the German Association of Gas and Water Engineers. [Applause.] Among those we are very proud that they have asked to come to us is Professor Hans Bunte. Professor Bunte's name and his work are almost as well known in England as among those who practise our profession in his own country; and I am sure that I could not express in words any exaggeration of the satisfaction we have in seeing him here among us. On behalf of the Council—and I am sure on your behalf also—I thank him cordially for having undertaken so long a journey, in order to bring to us the assurance of his colleagues' sympathy and goodwill. [Applause.] We have also here Mr. Ernst Körting, a gentleman whose views, I think I may say, are to us always full of interest and instruction. We welcome him most cordially. Dr. Bueb is also here; and his name, as you know, is known world wide, wherever the vertical retort is spoken of. I do not think that any words of mine were necessary in order to express the satisfaction with which we welcome these gentlemen to share in our rejoicings to-day; and if Professor Bunte would say a word or two we should be doubly grateful to him. [Applause.]

Professor BUNTE [who spoke in German, and the gist of whose remarks was subsequently given in English by Mr. Körting] said: The honour has been conferred on me, as one of the veterans of the gas industry in Germany, of conveying to the Institution of Gas Engineers, on the occasion of their jubilee celebrations, the heartiest wishes of the German Association. When your Institution first saw the light of day, half-a-century ago, ours had attained the tender age of four years, and is therefore slightly the older. But the conditions under which each was formed were widely different. The successors of Murdoch and Clegg had carried on their pioneer work, and had already spread the ideas of the founders of the gas industry to all parts of the world, and given a gas supply to many of the chief towns of the Continent. But the industry in Germany was still in a very elementary state of development. It is therefore only natural that the "Transactions" of the British Association of Gas Managers supplied the earliest instruction and encouragement for their German contemporaries, that we became their keen and industrious pupils, and that our visit to the motherland of the industry and its splendid works provided fresh experience, and urged us to renewed efforts. In the course of time your eager and grateful pupils became co-workers, and we felt highly honoured and rejoiced at the visit, towards the end of the last century, of some of your representatives to Germany. A few years ago, we were able to return this visit; and your splendid welcome, with its fulness of sincerity and encouragement, heartiness, and companionship, filled us all with the deepest gratitude, to which we would give expression again to-day, while offering you our best wishes. There is no bond of union between men and nations so strong as common striving in furtherance of the culture of mankind, which end our two Associations serve. And so, in the name of your German colleagues, I would wish ever-increasing prosperity to the Institution of Gas Engineers.

Called upon by the President,

Dr. MESSEL said: Have I been singled out to speak on this occasion that your Chairman may adorn himself with the scalp of his quondam foe? If so, let me assure you that nothing rankles in my mind. We had a square fight. One side only can win; forgive me if I express my regret that it was not I who came out the victor. More likely I have been called upon to address you as representing the largest Society of applied chemistry, the Society of Chemical Industry, and because yours is the largest and the most important chemical industry carried on in this country. Need I refer to your numerous products other than gas, to the part chemistry plays in your manufacture, and to its importance in the development of modern science and of modern industries. The manufacturer of gas and its bye-products is, on the other hand, not indebted to chemistry alone. He has availed himself of the achievements of physical and engineering science in no less degree. Hence, I find myself surrounded by representatives of numerous learned societies. In their name, and in my own, I desire to express our thanks for having been invited to be with you on the celebration of your jubilee, and may I wish continued prosperity to your great industry as well as to your Institution.

The PRESIDENT: We have buried the hatchet to which Dr. Messel referred. We won our fight. It was a fair, straightforward fight; and I do not think anyone will be the worse for it. ["Hear, hear."]

Presentation to Mr. Thomas Newbigging, D.Sc., M.Inst.C.E.

The PRESIDENT: Ladies and gentlemen, a happier incident wherewith to celebrate the jubilee of our Institution, I think, could hardly have been found by the Council and the members than that to which we are now about to give effect. To Dr. Newbigging was due, I believe, the conception of the British Association of Gas Managers. Certainly, it was he who brought together the first gathering of men in Manchester who decided upon the formation of our

Society. The child of his begetting has grown to healthy manhood, and we are very glad to have Dr. Newbigging here to-day to rejoice with us in its mature strength. [Applause.] For him the working days, by his good judgment, are over; but he sets us an example still by showing how the days of fruition and of leisure may be best employed. He has not lost his interest in the work of younger men. He takes a delight in books. Out of the full storehouse of his knowledge, he has (both in prose and poetry) contributed to the entertainment and instruction of a large circle. I think he will remember who, when enumerating the accompaniments which should go with old age, and which he might never himself hope to enjoy, summarizes them as honour, love, obedience, and troops of friends. Friends he has already in rich abundance—[applause]; and we hope that he will be spared for years yet of happy life to continue to enjoy them. I am sure that I echo your wish in saying I hope that, when he looks upon the admirable portrait which you have had prepared, and which I have now the very great honour to present to him, it will bring back to his memory some of the old friends to whom he is very dear. [Applause.]

An oil painting of Mr. Newbigging [see p. 903] was then unveiled, amid loud applause. Under the portrait were the following words:—

> Thomas Newbigging, M.Inst.C.E.
> Presented to him by
> the Members of the Institution of Gas Engineers
> On the Occasion of its Jubilee, 1913.
> Tom Mostyn.

Mr. Thomas Newbigging [who was greeted by the members rising in their places and applauding]: Mr. President, ladies, and gentlemen, I thank you, Sir Corbet, for the many kind words with which you have introduced me to this meeting, and you, gentlemen, for the way in which you have endorsed the sentiments our President has uttered. Most men in the course of their lives have heavy burdens placed upon them. It appears to me that one of the heaviest that I have ever had was to sit here and listen to what the President has said of me. It is not the good fortune of everyone to be told while he is yet alive that his services have been valuable. Fame of this kind usually comes posthumously. It appears strange to me when I ruminate upon it, as I sometimes do, that out of the twenty-four gentlemen who took part in the preliminary meeting of the British Association of Gas Managers, I should be the only living representative. I am the only living representative of the small group who sat round a table in the Royal Hotel in Manchester, in the month of December, 1863. To be the oldest living representative of such a gathering is a gift of fortune for which I can scarcely claim any credit, unless it be on the ground that I have husbanded my health—— by working hard. [Applause.] The fact remains that I am the single representative of the members who sat round that table. In this respect, I might be looked upon as a natural curiosity—a *rara avis*, or a kind of living dodo. But, if you do not object to it, I would prefer to be looked upon as a link between the past fifty years and the coming years of the Gas Institution. I knew each of the original members very well; and I have a kindly recollection of all of them. There is another thing at which I cannot help but wonder, and it is that I should have been actively engaged as an engineer before, I think, about one-half of my present audience was born. As Lord Dundreary used to say, "That is one of those things that no fellow can understand." But if I had the better of you at the beginning, you will have the advantage of me in the long run, because you will be actively engaged as engineers when I am permanently laid aside. There are many compensations at the end of a long life, when we add up the figures and strike a balance. With regard to what Sir Corbet has said about my literary work—referring, perhaps, more particularly to my "Handbook"—I will make the observation that no knowledge which is derived from books can for one moment equal what we gain from actual personal experience. Every gas-works in the kingdom offers opportunities for gaining this experience—the smaller works, perhaps, better than the larger ones, because the different departments are there more under the immediate supervision of the engineer. With regard to the portrait which you have subscribed, my doubts and difficulties have always been as to the worthiness of the recipient. ["No, no."] However, I must not impugn the judgment of the subscribers; and, therefore, Sir Corbet, I accept the portrait which has been so well painted by my friend Tom Mostyn as one of the greatest honours that has fallen upon me in the course of my long life. Those who are capable of judging, and who have the right to express an opinion, say that the portrait is not only a good one, but that it is a real work of art. I am glad to say that of the painting. In these few remarks I have been sufficiently personal, perhaps more personal than I ought to have been but how could I help it? You must blame the circumstance for my having adhered so closely to events within my own remembrance. I thank you sincerely for the kindly feeling which has prompted you to make this presentation to me. [Loud applause.]

Some Messages.

The Hon. Secretary (Mr. S. Y. Shoubridge) then read some communications that had been received, congratulating the Institution. These and others subsequently made public are grouped together on p. 998.

Mr. Thomas Newbigging and the Benevolent Fund.

The Hon. Secretary: I wish to announce that Mr. Newbigging has this morning handed me a cheque for fifty guineas, as a donation to the Benevolent Fund—of which, by the way, he is the oldest Trustee—to signify his high appreciation of the honour that has been conferred upon him in the matter of the portrait

The "Birmingham" Medal.

Mr. Edward Allen (Liverpool): Ladies and gentlemen, it is now my duty—and I esteem it a great honour—to ask the President, on behalf of the members of the Institution, to accept the "Birmingham" Medal, in recognition of the distinguished services he has rendered to the industry in so many ways. This medal was presented to our Institution by the Midland Association of Gas Managers in 1881, by their President, Mr. R. O. Paterson (who we are glad to see among us this morning); and it was received by Mr. Charles Hunt, who was the President of the Institution at that time. It may be remarked that the idea originated with Mr. Charles Hunt. It is pleasing to know that these gentlemen are still taking an active interest in the industry, notwithstanding the years that have intervened. In looking over the account of the proceedings in 1881, I find that the medal is described as a handsome work of art. On one side is seen a medallion portrait of William Murdoch, the founder of the gas industry; and on the other side is an allegorical picture. But in the centre there are medallion portraits of four of the important men in the early history of the gas industry—Clegg, Malam, Perkin, and Bunsen. The endowment fund was raised by the members of the Midland Association; and it was somewhat on the lines of our present method. The members of the Association contributed so much, the manufacturers contributed so much, and the shareholders in the gas undertakings in the district contributed a portion. Since 1882, when Sir George Livesey (then Mr. George Livesey) was presented with the medal, there have been seven other presentations—in 1884 to Mr. Frederick Siemens, in 1886 to Mr. Charles Hunt, in 1890 to Mr. Thomas Newbigging, in 1892 to Sir William Henry Perkin, in 1894 to Mr. William A. Valon, in 1897 to Baron Auer von Welsbach, and in 1905 to Mr. James W. Helps. It may be sufficient to say that the use of the medal on this occasion justifies its existence; for if such an opportunity were not at hand, we should have found it necessary to provide some token of our great appreciation of the high character and the distinguished services of the President at our jubilee meeting. The industry is greatly indebted to Sir Corbet for many things; and it would take more time than the present occasion affords to enumerate them. The list of undertakings which are greatly indebted to him for his technical advice and wise counsel is also too numerous to mention. But the result of many years of faithful and eminent services to the whole industry is seen in the fact that to-day he stands at the head of the profession, and is the acknowledged leader of the industry. During the year

now closing, the Institution has been placed under a great obligation to Sir Corbet. His acceptance of the office of President has given the prominence and value to the jubilee year which were required; and we are most thankful for the measure of help and strength that is vouchsafed to him, by means of which the added burdens and responsibilities have been so ably borne. It is difficult, Sir Corbet, to say in your presence all one would wish to say; and I find myself unable to fully express the admiration that is felt by the members of the Institution. Not that these feelings are limited to our members. Your fame is spread throughout the Empire. Our cousins in America would desire to be associated with us in this matter, as well as the representatives of the industry on the Continent where you are so well known. I am sure that over and above every other feeling in our hearts is an intense admiration of the high standard of personal character and professional conduct that your life has exemplified. Long before his Most Gracious Majesty bestowed upon you the honour of knighthood, your colleagues ennobled you in their hearts; and in now asking you to accept this medal, we hope that you will associate with it the affection, esteem, and admiration of every member of the Institution. [Applause.]

The PRESIDENT [who, on rising, was received with loud applause] said: There is one more bond of brotherhood between myself and Mr. Newbigging, and that is that I feel like he did when attempting to reply to the gift of his portrait. I feel that I have an extremely difficult task to perform. I am proud of the medal which you have presented to me; and I thank you for it. I shall not attempt to justify your choice. I know that it is largely due to personal goodwill; and heaven forbid that I should wish it were otherwise. But there is one claim that I can put forward; and I think it could be put forward probably with equal force by practically all whom I now see before me. It is that I have tried throughout my life to forward the interests of the gas industry and uphold the honour of our profession. Again I thank you.

Presentation to Mr. Shoubridge.

The PRESIDENT: Now, I have one more pleasant duty to perform, though it is tinged, as so many pleasant duties are, with a shade of pain. We are losing our most highly esteemed and able Honorary Secretary, Mr. Shoubridge, who finds that the duties crowded upon him are so heavy that he cannot give what he considers a fair amount of service to the Institution. I think I cannot do better than read what is inscribed upon the testimonial which I have shortly to present to him, because it expresses the feeling of the whole of the Council and my humble self. At a meeting of the Council held at Westminster, on the 15th of April, 1913, it was resolved—

> "That the Council of the Institution of Gas Engineers record their high appreciation of the most valuable and devoted services rendered to the Institution by Sidney Yarrell Shoubridge, Esq., during the six years he has so ably filled the office of Honorary Secretary. The numerous and varied duties appertaining to his office have been fulfilled with such unfailing courtesy and marked ability, as to call forth the heartiest expressions of gratification, not only from the Council of the Institution, but from the members generally."
>
> Signed by Corbet Woodall (President), Edward Allen and John Bond (Vice-Presidents), Walter T. Dunn (Secretary).

Mr. SHOUBRIDGE: Mr. President and gentlemen, I am sure I do not know how to thank you all for your kindness to me in electing me for six years in succession to this very honourable and enviable position, and for your great kindness in presenting me with this testimonial at the expiration of my term of office. The privileges of an Honorary Secretary are many, and are in themselves, I think, an ample reward for any labour he may have to perform in carrying out the duties. I therefore feel it extremely kind and good of you to thank me in this way. I really ought to thank you instead. I confess that I relinquish the duties of the office with considerable regret; but it is a matter of great satisfaction to me to know that the work will be handed over to the very capable hands of my old friend Mr. Price, to whom I am sure the members will extend the kindness they have always shown to me. I cannot sit down without saying how deeply I am indebted to our indefatigable, most courteous, and obliging Secretary, Mr. Dunn. He has done all the hard work, and has made the little work I have had to do both easy and pleasant. I sever my connection with him in that capacity with very sincere regret. Mr. President, members of the Council, and gentlemen all, I thank you very heartily, and very warmly.

The "London" and Institution Medals.

THE "LONDON" GOLD MEDAL.

The SECRETARY (Mr. W. T. Dunn) announced that the "London" gold medal, presented by Mr. H. E. Jones, had been awarded to Mr. S. Meunier, of Stockport, for his paper on the "Evolution of the Stockport Gas-Works."

The medal having been presented,

Mr. S. MEUNIER (Stockport) said: Mr. President and gentlemen, I need hardly say how deeply I appreciate the gift of this medal. Why it should have been awarded to me, I cannot say; whether the paper was worth anything or not, at any rate I can thoroughly assure you all that the medal will be appreciated by me, and certainly by my family.

THE INSTITUTION GOLD MEDAL.

This was presented to Mr. H. Townsend, for his paper entitled "The Incidence of the Day-Load Factor."

Mr. H. TOWNSEND (Wakefield) said the medal would always remind him of the very kind assistance he had received at the hands of the members of the Institution.

THE INSTITUTION SILVER MEDAL.

This medal was awarded to the late Mr. A. W. Onslow, for his paper on "High-Pressure Gas for Manufacturing Purposes." The presentation was made to Mr. Goodenough on behalf of the family of the deceased member.

The PRESIDENT (addressing Mr. Goodenough): I ask you to transmit this to Mrs. Onslow with the Institution's sincere expressions of regret at the premature loss of her husband.

Annual Report.

[See "JOURNAL" for June 3, p. 651.]

The PRESIDENT: I beg to move: "That the Council's annual report and statement of accounts, a copy of which has been sent to every member of the Institution, be taken as read, and that they be adopted."

Mr. EDWARD ALLEN (Liverpool): I have very great pleasure in seconding the motion.

The PRESIDENT: Now, gentleman, is the time to make any comments on the report that may occur to any of the members. May I suggest that time does not allow of a very lengthy discussion? I would ask that members speaking to the report should confine their observations as much as possible in the matter of time.

Mr. GEORGE HELPS (Nuneaton): Sir, I crave your indulgence for a few moments. I have nothing to say in the least unpleasant. With nine-tenths of the report I entirely agree. It is a record of a wonderful year of work; and it is because it is such a record of work that I think it would ill become us to pass it over without some little discussion. We are all here this week to take an interest in the papers that will be presented to us. They are open to discussion; and I venture to say, and most of you I think will agree with me, that this report is as important to the industry as any two papers that will follow upon it. There is no use in my alluding to the parts of the report with which I am in agreement with the Council; so I will get on at once to those parts with which I am not in agreement. With regard to the education of fitters, many members will remember that, in submitting the report to the Institution, the chief point of the submission was that there should be no examinations. Now, in the report it is laid down that the authorities of the City and Guilds of London Institute have been approached in the matter, and that they will not agree to undertake the work connected with this question

unless there be examination. The Council suggests that we accept the proposal. At present, gentlemen, I am dead-against the acceptance. Why cannot we stand on our own ground? Are we not important enough to run the education of our fitters without, if necessary, going to the City and Guilds of London Institute at all? Is it necessary? If we have not the spirit or the money to carry out this work ourselves, then let us jockey the matter a bit. If the City and Guilds of London Institute say we must have an examination, let us have it. Let the men sit for it, but let there be no certificates, and no passes; and that will amount to much the same thing as having no examination. Another matter I have to mention is with regard to the awarding of medals. Two years ago, at Glasgow, you allowed me to raise this point in favour of workers as well as the readers of papers; and the late President, Mr. Wilson, was good enough to promise that the matter should have the attention of the Council. I have never yet heard a word about it; and I stand up here again to say that the workers should be awarded something for the work they do. To go on year after year awarding medals for papers that are read at these meetings only to the readers of papers, I do not think is at all right. If the medals were originally provided for this purpose, there is something to be said; but even then, surely we should consider whether it would not be to the advantage of the whole industry to have these medals for competition throughout the country. I am not going to say that we should necessarily include the Junior Associations; but we should certainly allow such Institutions as the Midland, the Manchester, and other similar bodies, to come in; and the papers read at their meetings should be open to receive these awards that we have seen handed out to-day. Then there is the question of widening the Institution doors. Now this, gentlemen, is of great interest to all of us. It is a matter that is put off year after year. We are told that it is going to be done. We know that Rome was not built in a day; and we do not expect those gentlemen who have been working throughout the year, as the report says, to take on more work than they have done. But what I submit is, if there is more work to be done, let them call on the rank and file—some of you gentlemen who are sitting in the body of this hall. You can undertake the work; you can look into the question as to whether the door shall be opened wider or not; and you can submit the matter to the gentlemen who are on the Council at this moment. When there is work to be done, I submit there are plenty of men in the industry able to do it; it should not be laid aside because of the stress of other work. The remarks I have just made apply equally to a more important question, and that is having a building in which we can hold these meetings instead of having to depend on buildings that do not belong to us. I thank you, gentlemen, for allowing me to make these remarks. If it is necessary to move an amendment, that the report be sent back on the points I have indicated, I am quite prepared to do so; but if notice is going to be taken of the remarks, this course will not be necessary.

The PRESIDENT: May I say, in reply to the observations Mr. Helps has just made, that I have a notice before me of of an amendment to be moved by Mr. James Paterson, of Cheltenham, on the question of examinations. This will be seconded by Mr. Head, of Winchester. The amendment will, I think, meet the point he has raised.

Mr. JAMES PATERSON (Cheltenham): Mr. President and gentlemen, I desire to be as brief as possible; but I am sorry that I feel myself compelled to introduce to some extent a jarring note in this meeting. The matter I am going to refer to has already been brought forward by Mr. Helps. I have placed in the hands of the Secretary an amendment to the resolution now before us, which is to the effect, with regard to the education and certification of gas-fitters, that the proposal of the City and Guilds of London Institute be not adopted. That, Sir, is my amendment. I should like to disclaim any want of courtesy to Sir Philip Magnus. It is perfectly clear from the correspondence laid before us that he has gone very fully and considerately into the proposal of the Council; but the scheme that the Council have now been attempting to put into force was drawn up expressly with the idea, and with the full determination, of excluding any examination. By the word "examination," I should like to explain that I think the scheme means external examination, because in a paper to be read before us at this meeting—I refer to Mr. Goodenough's paper—there is mentioned a method of internal examination which to my thinking is the most desirable way of carrying on educational matters. This scheme was drafted and considered at a conference convened in the first place by the Manchester District Institution of Gas Engineers; and nearly all the English District Associations, except the Midland, were at the conference, as also were delegates from some five different trade and operative societies. I think I should not be divulging any confidences of that conference if I were to state that the scheme was adopted unanimously, and that it contains no provision for examinations. The trade organizations represented were most emphatic upon this point. If this meeting accepts the present recommendation made by the Council in their report, it accepts a radical and fundamental departure from the scheme of that conference, and a departure to which the trade societies will, I am perfectly convinced, show the keenest opposition. The societies, together with all our members, desire education above everything. The members are strongly opposed to submitting their gas-fitters to the ordeal of an examination test as a criterion of their ability. I do not wish to occupy any more of your time; but I should like to quote the words of another gentleman bearing out this point of view. I quote the following passage from Mr. Brearley's paper read at the meeting last year: "Under examination conditions, many candidates fail to do themselves justice; and their technical worth in practice cannot always be assessed by this means. This does not minimize the importance, however, of getting them to undergo systematic technical study." These are the words used by Mr. Brearley, which show his attitude and his opinion with regard to candidates who are sitting for the examination in gas supply; and I say they are far more weighty when applied to the case of a gas-fitter. I wish, in moving this amendment, to endeavour to save the Council (no doubt this is a somewhat presumptuous remark) from elaborating a scheme which will not, I fear, meet with general acceptance from the members, which will be emphatically rejected by the various trade societies represented at the conference, and which will not be found in actual practice to achieve the purpose for which it was intended.

Mr. H. C. HEAD (Winchester): I beg to second Mr. Paterson's proposal. In doing so, I do not want to take up your time at any length. I second what he says, as I feel that the recommendation of the Council, as worded in their most able report, is not at all in accordance with the recommendation which was sent forward from the conference. That recommendation was carefully worded so that the necessity of a qualifying examination should not appear. The matter was very carefully discussed at the conference; and, as Mr. Paterson has said, most of the members, and certainly all the trade members, were strongly opposed to it. I am not quite sure whether Sir Philip Magnus realized the intentions of the gas engineers when he wrote the letters which are reproduced in the report. He mentions in his letter of May 5 that he thinks gas-fitters are capable, intelligent people, who can pass examinations; and at the end of the letter he says it will be found year by year that the standard of the written examination may be raised. I think in this, as in many other things, the sting is in the tail. It foreshadows that the written examination is a thing that is to be made more and more difficult; and I for one fear very much that in days to come, instead of having a gas-fitter who comes to us with a recommendation from his master as a good practical man, he will wave a piece of paper in our faces, and say: "I have passed an examination." I am sure we shall all deplore that.

Mr. E. A. HARMAN (Huddersfield): I should like to make a few remarks on the report, not as a whole, which I am sure we all appreciate very much. I, for one, do not regard the education of the gas-fitter as the supreme object of the members of this Institution. One would think, from what has been said, that we had nothing to consider, or to deal with, except the education of the gas-fitter. Is the gas-fitter the only person connected with the gas industry of any importance? Apart from that, my object is to endeavour to take a practical view of the report, the last clause of which relates to the establishment or erection of a National Gas Institute. It is said that a Committee of the British Commercial Gas Association, of the members

of the Council of this Institution, and of the Society of British Gas Industries have gone into the whole question, and consider the time is inopportune to undertake the erection of such a building. My contention is that the time, though inopportune for the building of a national institute, is singularly opportune for the establishment of a fund which will have for its ultimate object the building of such an institute. I think the present time, being the jubilee of the Institution of Gas Engineers, and it being a time when our esteemed President is the President, not only of this Institution, but of the other two Institutions, is one that can be celebrated in an excellent way by the establishment of a fund having for its object the erection of a permanent institute. I consider it is perfectly disgraceful that the Institution should not have a home of its own. Nearly every other association in relation to science or politics or religious matters has its central home in London. We have them all around us. Without elevating our friends the enemy, we know the splendid institution they have on the Thames Embankment; and I think it is unworthy of the history of the British gas industry that it does not take some steps at once to remedy this defect. A great many things might be urged in its favour. I do not propose to enter on them. I do not know whether I am in order in moving a second amendment to the report.

The PRESIDENT: Yes, you are in order; but I think we had better deal with the earlier amendment first.

Mr. HARMAN: Then I will leave it until the first amendment has been dealt with. My amendment is that it is desirable to celebrate the jubilee of the Institution of Gas Engineers by the inauguration of a fund for the establishment of a National Gas Institute, and that the Council of the Institution be requested to undertake the initiation of such a fund.

Mr. H. E. JONES (London): I would suggest that the amendment should be modified a little, and that, instead of making it absolutely final, it should be that the Council be asked to further consider the subject. I think in that form it would be more respectful to the Council, and it would secure the object we most of us have in view. I personally am impressed with the fact that it is too much the day of examinations. I used to be a Governor of the People's Palace; and I can only say my experience there was that there was too much of the paper, and too little of the hammer and chisel. I should like to appeal to the mover to let this matter go back to the Council for further consideration only, and not come to a definite result.

Mr. E. H. HUDSON (Normanton): I think this matter ought to be dealt with at the present meeting. I have been connected with this movement from its inception by the District Associations; and I can only say that from time to time, as the trade organizations were asked to join in our deliberations, the scheme was modified to meet their wishes. I would remind the mover and seconder of the amendment that in the scheme which was sent forward to the Council it was stated that the City and Guilds of London Institute was to be the educational authority approached. As I say, this scheme has been modified from time to time to meet the wishes of other people; and the Council have for their part modified it to the extent of submitting to the inevitable, which is that the City and Guilds of London Institute will not take up the education of gas-fitters unless there is some form of simple written examination to place upon their records. They agree with us; and I would like to remind Mr. Head that Sir Philip Magnus thoroughly understands the question from beginning to end. The Committee spent some time with him, and explained it in all its details; and I may tell you that we did not yield on the question of examination without a fight. I for one place very little reliance on the value of a written examination for a gas-fitter; but we have it thoroughly understood with Sir Philip Magnus that the examination is to be a practical one, and is to be supplemented by a simple written examination for the purpose of embodying in their records. If you accept the amendment that has been placed before you, you will put back the work of the District Associations for the last three years, and the work of your Council for the last year, and you must commence on a new scheme entirely. Now, the new scheme can only be such a one as is mentioned by Mr. Helps, and that is that the Institution should take up the education of gas-fitters themselves. Now, I put it to you, can we give a diploma or a certificate which will be of the same value as one from one of the recognized educational authorities of the country? I do not think we can; and I would also remind you that it is not our own gas-fitters particularly whom we want to educate, because we do keep a staff qualified to do our work. It is the outside gas-fitters whom we wish to bring in. How are you going to bring them in by any scheme managed by the gas undertakings? I ask you, gentlemen, to take the scheme as it is. I would remind you that the man who will not take a thing because he cannot get all he wants is an enemy to progress. We ought to try the scheme, and put it into practice. These are things that we have striven for the last three or four years in the District Associations, and during the last year in the Institution. I do not know that I can say any more about this. I ask you to decide on the question definitely once for all to-day, because if you refer it back to the Council they cannot move an inch further without you recommend to them a new scheme. The scheme brought forward a year ago embodies this scheme. They do not ask you to introduce a new scheme, but to consider the scheme that you have prepared. They have kept to the scheme literally, till they were met with this deadlock from the City and Guilds of London Institute on the question of a simple written examination. You will have to draft a new scheme entirely, if you refer this back to the Institution.

Mr. J. C. BELTON (Chester): Sir, I wish to say a few words on the report; but, with your permission, I will wait until the amendment has been disposed of.

Mr. H. KENDRICK (Stretford): Mr. President, ladies, and gentlemen, I rise to speak to the amendment brought forward by Mr. Paterson. It was with extreme regret that I read the report of the Institution, even after a conversation I had had with Mr. Hudson, who has so ably seen carried through the work of the education of gas-fitters. As Chairman of the Manchester District Institution Committee who drew up the first scheme, I can carry my knowledge a little further back than Mr. Hudson, to whom our great thanks are due. The scheme as now brought forward is practically the same as that which was originally proposed by the Manchester Committee, and despite everything Mr. Paterson says about its unanimous acceptance by the conference representing both the trade of plumbers and the gas-fitters and the gas engineers, held in Manchester, I fear that his impression is not quite the same as my own. It seemed to me that the trading element at that conference was not quite so keen upon having an unwritten examination as were Mr. Paterson and his friends from the South. We, in the North, accepted Mr. Paterson's suggestion that the scheme should go through without a written examination, on purpose to get the thing started. A considerable number of us in the North were more or less of opinion that a short written examination would be the best. The scheme in its present form, despite what some of our friends have said, would receive a large amount of support in the northern half of the Institution's ground, where it was first conceived. I have had some little experience of imparting instruction in gas-fitting work at one of the technical schools in the Manchester district. I had there about sixty students, to whom I gave a written examination; and I must say that at least forty of them sent me in replies which were worthy of much better educated men. There will always be a substratum of men who have lost their elementary education at the age of eighteen, when they begin to find that they have missed something; and it is these men who will perhaps suffer. As Sir Philip Magnus has said, I think that as time goes on under this scheme there will be an improvement in the status of the gas-fitter, and that he will rise to the occasion like Britishers always do. I have great pleasure in supporting the report of the Council that we accept the scheme as approved by Sir Philip Magnus. There is one other matter in the report I wish to refer to which has not been mentioned by anyone else, and that is with regard to the income-tax depreciation. The Company that I represent is one that stands outside; and my advice to others is, if they can do the same as some twenty or thirty of us have done, they will get on much better than they would under the scheme accepted by the Council.

Mr. A. E. Mottram (Ossett): As a member of the original Committee, I should like to strongly oppose the amendment. I have already said in another place that I did not see that there was any fear of the examination. The only question is as to the way in which the examination is conducted. The Manchester Institution had the examination in view until Mr. Paterson side-tracked it. I hope we shall arrive at some system of examination that will suit all parties.

The President: I have no disposition to check the discussion in any way; but time is getting on rapidly, and unless somebody is very keen to add to what has already been said, I will now put it to the vote.

Mr. Walter Hole (Leeds): May I say a word in addition to what has already been said? I oppose altogether the amendment. I fail to see where such a simple written examination could be the bogey it is made out to be. I am, as you know, Examiner in Gas Supply; and there is one fact I should like to draw your attention to. This year, in the elementary classes, there have been nearly 400 candidates sitting; and I should say from the penmanship, and the general character of the composition and the answers given, quite half of that number were from the rank of fitters. Therefore, if, out of 400, 200 can sit for an examination of this kind, I fail to see why a very much larger number should not sit for an extremely simple written examination, taken in conjunction with the practical examination suggested.

Mr. Jones: Several of my friends around me have suggested that I should put what I have said in the form of an amendment. I shall be most happy to do so.

Mr. R. W. Edwards (Aldershot): I beg to second that amendment.

Mr. Daniel Irving (Bristol): I am in favour of a practical examination accompanied by a simple written examination, as proposed by the Council. I would suggest that the only thing we can do is to loyally support our Council, who have brought this matter to the point at which it is now placed before you.

The President: Gentlemen, I am always glad to have the opportunity of hearing men who have given thought and attention to any matter under discussion; and we have had that in the observations that have been made, especially by Mr. Paterson. He has thought very carefully over the matter; and he has come to the conclusions that he has placed before you. I think the discussion that has taken place has been exactly what such a discussion ought to be. There has been no temper whatever, but simply argument for and against. It should be clearly understood that the written examination is a very simple one indeed, and does not interfere with the practical examination which will lead up to it. Then, again, it has been said that the examination should be internal, and not external. It has also been remarked by one speaker—I do not exactly remember who—that when men have left school they find what it is that they have lost. Then it is they find that they have lost something—in fact, a very great deal; so that soon after leaving school they are glad to get back again to have the opportunity of a little technical and oral teaching to make up the leeway. It is quite possible in a very large undertaking such as some of those who have spoken represent, to have this internal examination. I felt very keenly years ago that it was a shame that we should send men to consumers' houses to learn their business, at the expense of the consumer to a large extent; and so the Gaslight and Coke Company instituted a scheme of teaching which has been carried on now for six years with the most marked and admirable results so far as the Company are concerned. Above all things, we arrange to take a number of boys every year from the elementary schools, bring them into the shops, give them practical instruction at the hands of capable mechanics and artisans, and at the same time arrange for them to carry on for three afternoons in the week their education in one of the County Council Technical Schools. Now this scheme has turned out some 150 really capable fitters. The earlier ones are earning their full pay, and they have proved to be really capital men. If a man has not the capacity to write answers to technical questions, he is not lost sight of because of that. Those who conduct the examinations know the man; and the man is not hampered by the fact that he has not the capacity for going through an examination. I think Mr. Hudson made it clear that the alternative to the adoption of the Council's report is really the dropping of the scheme, and commencing to form another. I understand that this was referred by the District Associations to the Council for them to act upon, and especially for them to see Sir Philip Magnus and arrange with him. The advantage of having the City and Guilds of London Institute as an examination centre for all over the country is too palpable to need enlarging upon. Sir Philip Magnus made it clear that, while the written examination should be as simple as it possibly could be, there must be one, if they were to have anything to do with it, as they could not go away from their regulations. I hope, gentlemen, that I have not confused the issues at all. Now, Mr. Jones, would you put forward your suggestion definitely?

Mr. Jones: I propose that the Council should further consider it. I must say that I do not feel very strongly upon this.

Mr. Paterson: I am willing to alter my amendment on the lines suggested by Mr. Jones.

The President: Then, gentlemen, I will put it to the vote. Please understand that there is no reason why anyone should hesitate one particle about voting against the recommendation of the Council. If you are in favour of referring back the matter for the reconsideration of the Council, please to hold up your hands. [A few hands were held up.] The number is very small. I do not think it worth counting. I will take Mr. Jones's amendment as the original amendment. Those against the adoption of the report? It is carried by a very large majority. Now I would merely ask you, gentlemen, in your several regions to carry out the scheme to the best of your ability. I call on Mr. Belton.

A National Gas Institute.

Mr. Belton: I will not take up your time very long; but I am anxious to say a few words in relation to the matter mentioned by Mr. Harman. While I should shrink from challenging any of the conclusions arrived at by our excellent Committee, I think it is a pity to pass by with just the small reference contained in the last paragraph of the report such an important matter as that of a National Gas Institute. I, for my part, look at the question from a wider standpoint than that taken up by Mr. Harman this morning. I regard a National Institute, not only as a place in which we as gas engineers can conduct our business, but what I am desirous to see—and I believe in the possession of that desire I have the sympathy of a great number of those before me this morning—is the united gas industry formed into a National Gas Institute, having, as I hope it eventually will have, its own National Gas Institute building in London, in which all our business can be conducted. We have at the present time before us a very powerful opposition against which every gas company and every gas committee in the land is contending. This opposition opposes, not merely the Institution of Gas Engineers, but the other two great Associations which are now formed for really the same purposes as our own Institution. I mean the Society of British Gas Industries and the British Commercial Gas Association. While we have a great and very united force opposed to us, our own forces are lamentably divided. We have three great armies fighting, with unity of purpose, against one common enemy; but we have no union of forces. What we want is not three independent armies—though I am happy to say at the present time the Commander-in-Chief is the same for all three. We want the happy position in which we stand to-day to be rendered permanent. We want to unite our forces, and we can only do so by the amalgamation of the three Societies I have named into a great National Institute, having one President, and having, as I hope we shall have, one home in this great city, which shall stand in the eyes of our own people and in the eyes of our visitors from beyond the seas as the nation's testimony to the great industry carried on in our midst. I wish to support Mr. Harman in what he has said; but I would like to add to it

this rider: "That, while we accept the report as it stands, we earnestly request the Committee of the Institution to take into consideration at the earliest possible moment the advisability of calling together a Committee composed of representatives from the Society of British Gas Industries, the British Commercial Gas Association, and our own Institution; and that it be from this meeting a recommendation to the united Committee to do their very best to formulate a scheme to carry out the idea of a united National Gas Institute." [Applause.]

The PRESIDENT: May I suggest that we leave this matter where Mr. Harman and Mr. Belton have carried it? The question has not been lost sight of by the Council of the Institution. We did informally appoint such a Committee as Mr. Belton has recommended; and the Committee had, I think, two meetings, We obtained some information in regard to possible sites, the cost of the sites, and the cost of the buildings to be erected thereon; and then we went into the question of finances, as to how far we could see our way to providing the necessary funds. We found that the total annual cost would be so large in proportion to our possible means at this time, that we felt obliged to forego it for the present. You may rest perfectly assured that the matter, whoever may be on the Council, will not be lost sight of. I will say, for myself, if you will allow me to do so, that it was a great disappointment for me, because I had hoped that we might in this year of our Jubilee have been able to do what the gentlemen who have spoken so much desire. So far as I am personally concerned, I should have done all that in me lay to advance it, if we had been able to start with any prospect of immediate success. The matter will be referred to the Council and considered in the way suggested.

Mr. BELTON: May I be allowed to suggest that the matter should not be looked at first of all from the point of view of providing a building?

The PRESIDENT: As you have already spoken, I am afraid I cannot allow you to address the meeting again. You have put your points perfectly well.

Mr. ISAAC CARR (Widnes): I would like to suggest that Mr. Harman might bring forward his amendment to the report coupled with the rider suggested, so that the sense of the meeting might be taken on this great important question. As I have said, it is a matter of great importance. We have for years past been faced with the fact that members of the Institution make use of it in a way that our outside friends are unable to do. I hope that the Committee will see their way to give an instruction to the Council, so that the suggestions which have been brought forward to-day for bringing about a united gas industry may be carried into effect. While I agree cordially with Mr. Harman's recommendation, I would suggest that Mr. Belton's amendment should be added as a rider.

Mr. HARMAN: I shall be quite willing for the rider to accompany my proposition.

The PRESIDENT: Do you wish to take the sense of the meeting upon it?

Mr. HARMAN: By all means.

The PRESIDENT: Then I will put the amendment as proposed by Mr. Harman, seconded by Mr. Belton, that it be a reference to the Council to consider. There are two very definite and distinct proposals. One is for amalgamation with the Society of British Gas Industries and the British Commercial Gas Association, and the other is for the provision of a home.

Mr. JONES: I hope, Sir, you do not mean to put this to the meeting without hearing something from the other side about it. As you very properly point out, there are two distinct issues. Surely we are present here to-day as engineers, working in a scientific and professional capacity. We are not so weak that we cannot stand without being bolstered up in our constitution by outside support. The proposed instruction to the Committee goes to the very foundation of our existence. It is much too important a matter to be put forward in a hasty way—namely, that the Council should be instructed at this meeting that the fusion should take place. I entreat my fellow engineers in the Institution to remember what they are. I ask them to remember that they are a scientific and professional Institution. I will not discuss it at greater length, because we have already occupied so much time with it; but I appeal to you, gentlemen, that you will not send a definite instruction to your Committee which shall give the appearance that we as engineers do not feel that we can stand alone as a separate gas engineering profession and Institution.

Mr. HEAD: Will you put the two points separately?

Mr. HARMAN: My proposition was that it is desirable to celebrate the Jubilee of the Institution of Gas Engineers by the inauguration of a fund for establishing a National Gas Institute, and that the Council of the Institution be respectfully requested to undertake the foundation of such a fund. That was my proposition.

Mr. BELTON: I cannot second that as it stands, because it is premature. We must have union first.

Mr. JONES: I should like to second that. I draw a wide distinction between the provision of a home for the Institute and the fusion of these bodies.

The PRESIDENT: Those who are in favour of Mr. Harman's resolution will please signify the same. On the contrary. The resolution is carried. Now, Mr. Belton, if you wish to press yours as a separate resolution, you can do so; but I hope you will not.

Mr. BELTON: I will let it drop, Sir, for the present. ["Hear, hear."]

The PRESIDENT: Having disposed of the amendments, I will now put the adoption of the report. On the contrary. It is carried unanimously.

Resolution as to Canal Traffic.

The SECRETARY: Gentlemen, it has been suggested that the following resolution be passed at this meeting:—

> That this Institution, having in view the cheaper transit facilities due to canal development in Germany, France, and Belgium, the countries chiefly competing with our manufacturers in our own and foreign markets, the congested conditions of transit of heavy and bulky goods in this country, and the consequent hindrance to trade, urges the Government to take immediate action upon the report and recommendations of the Royal Commission on Canals appointed upon their advice, by introducing a Bill to give immediate effect to paragraph 973, sub-sections 1 and 2 of the report, which recommend the appointment of a Waterways Board, and the acquisition by the State of the four trunk or main canal routes (referred to as "The Cross Report," paragraph 485). The Waterways Board acting as the Controlling Authority to be toll-takers only, not carriers (report, paragraph 815). That a copy of the foregoing resolution be forwarded to the Prime Minister, with a request to support any proceedings which may be taken in the House to give effect to the above resolution, and that the Secretary of the Waterways Association be advised.

Mr. T. BERRIDGE (Leamington): With your permission, Sir, I should like to move this resolution. It is a very important matter to all gas-works. The idea is to make a canal from Liverpool to London, and from Hull to Bristol, which will have connections fifty miles all round. We know the great improvements that have been made in the canal and water traffic in France and Germany, and other nations on the Continent. We know the difficulties we are having with the railway companies, who are putting up their rates on some goods; and it will not be very long before they put them up on coal. We know, further, that we represent at this meeting a capital of something like 200 millions of money. Therefore, it is very important to us that we should have proper facilities for the transit of our goods and raw materials. I have very great pleasure in moving this resolution.

Mr. BELTON: I beg to second the motion.

The PRESIDENT: Those in favour of the resolution. On the contrary. It is carried unanimously.

President's Address.

The President then delivered his Inaugural Address, which was given in the "JOURNAL" last week, p. 793.

At its close,

Mr. J. FERGUSON BELL (Derby) said: Gentlemen, I have much pleasure in proposing that the best thanks of the Institution be accorded to our worthy President, Sir Corbet Woodall, for his most instructive, lucid, eloquent, and admirable address, to which we have listened with so much pleasure this morning. I am sure I voice the opinion of all the members of the Institution, when I state that the selection of Sir Corbet Woodall to be our President, on behalf of the members of the Institution, was a most happy one. Naturally, during our jubilee year we were anxious to obtain a gentleman holding a leading position in our profession; and it was with exceeding pleasure that I heard that Sir Corbet Woodall had agreed to occupy the position—an expression of opinion which I am certain will be echoed by every member of the Institution. We all know something of the great administrative work that Sir Corbet has done as Governor of the largest Gas Company in the world. By that work, he has not only benefited the Gaslight and Coke Company, but I venture to say that he has benefited the whole of the industry. Sir Corbet Woodall is a great administrator and a great engineer; and, therefore, we were very glad that he was prepared to give his valuable time to the Institution. I have no hesitation in saying, Sir, that you owe your position not only to your great ability, but in a large measure to your charming manner and personality. The address to which we have listened this morning shows what a masterly grasp you have of all the questions connected with this great industry of ours. Gentlemen, Sir Corbet Woodall has this morning more than fulfilled our most sanguine anticipations by the way in which he has presided over us; and I think I may say that we have made a good beginning for our jubilee meeting. I venture to say that the selection of Sir Corbet Woodall as the President of the Institution did not confer any honour upon him, but that he, by presiding over us, has conferred honour upon our Institution. It requires no more words of mine, I think, to commend to your hearty reception a cordial vote of thanks for the address to which we have just listened. We shall all I am quite certain re-read that address with great pleasure and profit. It was only possible for one who has been for a great number of years a leader of our industry to give us so masterly a review of the topics which are of interest to us. Sir Corbet Woodall, for a great number of years, has occupied the foremost place in our industry; and I am quite sure everyone will join with me in wishing that for many years to come he will adorn the position he now holds. I was very pleased to hear the sympathetic references in his address to labour—sentiments which I am sure will be echoed by all. I think, although there is strife abroad, the gas industry are to be congratulated upon their exemption to a very large extent from those labour troubles to which reference has been made. Undoubtedly, the industry's freedom from these troubles is because of the kindly sympathy to employees which you, Sir, have set forth in your address. I agree our duties do not end in paying a fair wage, but we should endeavour to make all our employees better men, and so better citizens. Gentlemen, in conclusion, it requires no words of mine to commend to you this address. Therefore, I will ask you to accord a very hearty vote to Sir Corbet Woodall for his instructive and illuminating address.

Mr. WILLIAM KING (Liverpool): Gentlemen, when, in the course of the proceedings this morning, I was requested to second the vote of thanks to our President, I felt very much honoured; and I have great pleasure in acceding to the request—first, because I am one of the very oldest members of the Association, but specially because I think there is no man in this building who has known the President as long as myself. We were boys together. Our friendship began then, and has continued uninterruptedly till the present hour; and I hope for some years to come we may still enjoy more or less of each other's society. I regret that the distance of our residences from one another keeps us apart, and prevents more intimate social intercourse between us. I am sure, gentlemen, that I shall be serving your interests best, and I shall please Sir Corbet Woodall most, by confining my remarks to one or two observations. I am only expressing, on behalf of the Association, our very best thanks to the President for what he has done. We know the busy life he lives. We have enjoyed his address; and I may on your behalf, I am sure, express a hope that his health and strength will not suffer from the very great demands we are making upon him this week. I will not detain you any longer, gentlemen, because it will only weary you if I add any further to my remarks. I most cordially second the motion. On behalf of the Institution, Sir, I wish to convey to you our very best thanks, not only for the services rendered this morning, but for the great services you have rendered in the past to the industry in which we are all so deeply interested. As, gentlemen, Sir Corbet Woodall cannot put this to the meeting himself, I will ask you to carry it by acclamation, and to show in every way your thanks to him for the great work he has done on our behalf.

The motion was adopted amid loud applause.

The PRESIDENT: Gentlemen, I thank you very heartily indeed for the way in which you have received this vote. I thank you also for the extreme patience with which you have listened to what I felt to be a very long, and I fear a very uninteresting, address. The vote is peculiarly welcome to me, having been proposed by my friend Mr. Ferguson Bell, who, as you know, in the most kindly way, stood on one side as the proper successor to this chair, in order that I might be asked to take it. I will say no more than that; but I must say that I felt it very much indeed, that any member of the Institution should have so much self-abnegation. I am also very thankful indeed that it has been seconded by my dear old friend Mr. King. It carries me back not fifty years, but more than that, to a time when I went, through my elder brother, to consult Mr. King and his father on the design of the works of which I was then the Manager, and of which I see my successor present before me now. I shall never forget the kindly way in which they both received me. Mr. King, senior, was away; but Mr. William King went through my drawings with me in the kindest possible way; and I shall never forget it. These associations are very grateful to one, at a time like this, when one has got into the "sere and yellow leaf." Gentlemen, thank you very much indeed.

The conference then adjourned, and at the opening on Wednesday,

The PRESIDENT said: I have two telegrams that have been received since the opening of the meeting, which I shall have much pleasure in reading to you. They are from the German Continental Gas Company and from Mr. Walter R. Addicks, the President of the American Gas Institute. [See p. 998]. Mr. Addicks I had much hoped to have seen present here; but he has been detained. I am pleased to announce that Professor Sylvanus Thompson is with us this morning—I am sure we shall all welcome him very cordially. [Applause.]

REFRACTORY MATERIALS COMMITTEE.

The report of the Refractory Materials Committee was then presented by Mr. F. J. BYWATER (London). It was as follows:

It will be remembered that the Committee included in their report last year the third section of the standard specification; and as some little time will inevitably be necessary for the manufacturers to become accustomed to preparing goods in accordance with the specification, it was thought advisable, instead of undertaking any new work this year, to inquire into the working of the first section—viz., that relating to retort material, and which was issued in December, 1910.

As a preliminary to this, fourteen samples of retort material, which had been purchased in accordance with the specification, were obtained from ten representative gas-works, and have been tested by Dr. Mellor, the Director of the County Pottery Laboratory, Stoke-on-Trent, and the

results obtained are shown below. The standard test is printed in heavy type at the head of each column.

Works from which Samples were Obtained.	Refractory Test.		Contraction or Expansion. Per Cent.	Porosity.
	Seger Cone.	Fahr.		Per Cent.
	28	**2966°**	**1·25 max.**	**18 min.**
Works—A . .	29–30	3020°	*nil*	26·35
,, B . .	29	3002°	0·320 con.	22·37
,, C . .	30	3038°	1·095 ,,	24·90
	29–30	3020°	0·175 ,,	28·58
,, D . .	28	2966°	1·234 ,,	30·88
,, E . .	28	2966°	0·343 exp.	22·37
	28	2966°	0·361 con.	23·80
,, F . .	28–29	2984°	2·670 ,,	27·74
	29	3002°	2·123 ,,	28·82
,, G . .	26	2876°	0·943 ,,	21·00
,, H . .	28	2966°	0·885 ,,	23·98
	29	3002°	0·500 ,,	26·755
,, J . .	26	2876°	0·612 ,,	23·58
,, K . .	31	3074°	1·030 ,,	22·10

N.B.—Where two samples were tested from one works, the figures refer to material from different firms.

The result of the investigation will probably be considered to be fairly satisfactory—only two samples failing to comply with the "refractory," and two with the "contraction" test—although the Committee would have been very glad to find that all the material, which was purchased to strictly conform to the specification, actually did so. All the samples withstood the porosity test very well—in fact, some of the material would probably be better for being a little less porous, owing to the increase in physical strength which would thereby be obtained.

It is obvious, however, that engineers should (either in collaboration with the manufacturer or independently) always have tests made if they wish to ensure obtaining material of uniform quality. The Committee will probably arrange for a similar set of tests to be carried out next year on standard specification material supplied to various works, in order that the fullest possible information may be obtained and published with regard to what is being done.

Inquiries have also been made from a number of engineers who have received standard specification material, as to their opinion of it; and these have revealed the fact that, whereas complete satisfaction is expressed at the quality of the fire-brick material generally, two complaints are made by several engineers against standard specification retorts: First, that some of them were too friable, and lacking in physical strength; secondly, that the surfaces of the retorts made by several manufacturers were covered with small cracks. Both of these complaints can be discussed together, as they bear close relation to each other.

Before undertaking the preparation of the specification, the Committee had tests carried out on a large number of representative samples of retort material; and as a result of these tests, and acting on expert advice, they decided that, having regard to the range of temperature in which retorts work (there is sometimes a fall in the temperature of the retort of more than 1000° Fahr. when it is charged), much of the material was too dense and close-grained, and that a test for porosity must be inserted in the specification, in order to ensure a fairly open texture. As a corollary to the porosity test, it was also decided to specify that the fine dust should be excluded from the burnt clay or grog. This latter is the only manufacturing detail into which the specification enters; and although the Committee were very unwilling to attempt to dictate to the manufacturer in the matter of his works' operations, the expert advice given them was very strongly against allowing the fine dust of the burnt clay to be put into retort mixtures. Accordingly a minimum porosity of 18 per cent. was fixed; and all dust which will pass through a sieve with sixteen meshes to the inch is to be taken out of the grog.

It was thought that these clauses were moderate, and would not cause much anxiety to the manufacturer. But, unfortunately, one or two (in their desire to be on the right side) increased very considerably the size and quantity of the burnt clay ingredient—in fact, put in more than the raw clays or matrix could "carry;" and as a consequence the resulting material was too friable, and contained surface cracks.

With regard to friability, there are retorts working in this country to-day which are already credited with a life of 2000 days, and which are exceedingly soft and porous. But they were made by manufacturers having very intimate knowledge of their clays and mixtures; and it would appear to the Committee that those manufacturers who have had to alter their mixtures recently, should for the present aim at obtaining a porosity of 23 to 25 per cent., until they have obtained complete experience of the capacity of their clays to carry larger quantities of burnt clay or grog than they have hitherto been accustomed to.

The surface cracks are caused by the different contraction which takes place in the grog and the matrix when the material is being fired in the kilns, and which causes the matrix (which has the greater contraction) to shrink away from the particles of grog near the surface, and so causes cracks.

It is believed that the manufacturers responsible for the material have now, fortunately, overcome this trouble; but the Committee wish it to be understood that standard specification material ought not to contain these extensive surface cracks, and that the porosity specified can be obtained without the material being very friable or incapable of withstanding on this account the ordinary wear and tear of retorts.

It was suggested in the discussion on last year's report that the test for refractoriness is not sufficiently stringent. But the Committee are of opinion that a margin of about 1000° Fahr. above the average working temperature of retorts should give a sufficient factor of safety; and though they keenly desire to obtain high-grade retort material, they do not think the time has yet arrived for raising the standard of this test.

It has also been suggested that the test sample should be "under load" when being tested, and in a "reducing" rather than in an "oxidizing" atmosphere, as specified.

As to the first suggestion, the Committee have already considered this matter, but did not think it advisable to specify such tests, because of the almost entire absence of reliable data relating to them; and they were of opinion that it would be very inadvisable to specify tests of which the fullest possible information and experience were not available. They will, however, be glad to have any such tests brought to their notice, and will give them close consideration.

The question of the atmosphere in the test-furnace was also carefully considered at the time the specification was prepared.

It is, of course, quite true that the atmosphere in retort-settings is frequently "reducing" in its composition, and also that with refractory materials of certain composition tests carried out in a reducing atmosphere are somewhat more severe than in an oxidizing one. But the difficulties in the way of specifying such a test are very great. The information at present available to the Committee shows that it is practically impossible to obtain reliable results in such cases, as the effect of the temperature will vary considerably according to the percentage of reducing gas in the furnace and oxides of iron, &c., present in the refractory material. The regulation of such an atmosphere would be most difficult to maintain constant in its composition; and having regard to the fact that the Committee have constantly sought to make the tests as simple as possible, it will be readily understood why they decided upon an oxidizing atmosphere. At present they see no reason to alter this provision, which is based on the practice in the largest clay-testing laboratories in this country and on the Continent. It is felt, moreover, that the factor of safety which has been allowed is ample for any possible prejudice to the purchaser on this account.

It has recently been brought to the notice of the Committee that at times engineers are in doubt as to where they can have tests carried out in accordance with the standard specification. It is therefore proposed to inquire into this matter and publish a list of analysts or laboratories where these tests are undertaken.

The Refractory Materials Committee are of opinion that a supply of retort and fire-brick material of the highest quality is of very great importance to the gas industry; and they would be glad if engineers and others who are interested in this subject would place their experience, and any information they possess, at the disposal of the Committee. The whole subject is an involved one; and the Committee will welcome free discussion, and criticism if necessary, as they recognize that it is only by this means that the fullest possible information can be supplied to the manufacturers as to the needs of the industry in this matter.

Mr. BYWATER, in moving the adoption of the report, said: Mr. President and gentlemen, as the report has been circulated, and is before you, I will not take up time in reading

it all through; but I would like to call attention to one or two points in it. As we state in the report, there are one or two of the samples which have been tested which fall below the Committee's standard—two for refractoriness, and two for contraction. I would also like to call attention to the fact that in the porosity tests all the samples are above the minimum—in fact, most of them are considerably above the minimum. There are paragraphs in the report that I would like to read, which are as follows:

> It is obvious, however, that engineers should, either in collaboration with the manufacturer, or independently, always have tests made if they wish to ensure obtaining material of uniform quality. The Committee will probably arrange for a similar set of tests to be carried out next year on standard specification material supplied to various works, in order that the fullest possible information may be obtained and published with regard to what is being done.
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> Inquiries have also been made from a number of engineers who have received standard specification material, as to their opinion of it; and these have revealed the fact that, whereas complete satisfaction is expressed at the quality of the fire-brick material generally, two complaints are made by several engineers against standard specification retorts. First, that some of them were too friable, and lacking in physical strength; secondly, that the surfaces of the retorts made by several manufacturers were covered with small cracks. Both of these complaints can be discussed together, as they bear close relation to each other.
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> Before undertaking the preparation of the specification, the Committee had tests carried out on a large number of representative samples of retort material; and as a result of these tests, and acting on expert advice, they decided that, having regard to the range of temperature in which retorts work (there is sometimes a fall in the temperature of the retort of more than 1000° Fahr. when it is charged), much of the material was too dense and close-grained, and that a test for porosity must be inserted in the specification in order to ensure a fairly open texture. As a corollary to the porosity test, it was also decided to specify that the fine dust should be excluded from the burnt clay or grog.

Then the report goes on to mention what these tests were:

> It was thought that these clauses were moderate, and would not cause much anxiety to the manufacturer. But, unfortunately, one or two (in their desire to be on the right side) increased very considerably the size and quantity of the burnt clay ingredient—in fact, put in more than the raw clays or matrix could "carry;" and as a consequence the resulting material was too friable, and contained surface cracks.

I would like to say with regard to these remarks, that it is undoubtedly the fact that in some cases these standard specification retorts have failed to give satisfaction to the engineers. The Refractory Materials Committee do not wish in any way to shield manufacturers; but they do feel that, in taking the responsibility for part of the trouble which has arisen, some little blame must be borne by the manufacturers, because there is nothing in the specification which should cause what are called "rotten" retorts, by which I mean retorts that are physically lacking in strength. It is necessary for retorts to have a considerable amount of physical strength. It is a pity that the manufacturers, who have met us most handsomely, in their desire to improve the materials, have gone too far over in the other direction, and have made retorts which lacked physical strength. I have in my mind one manufacturer who supplies a lot of retorts in this country. He has shown himself very desirous of improving their make; but unfortunately, and he admits it himself, he made a large blunder in trying to put in too much burnt clay, and so the retorts became physically weak. There is also a mention in the report with regard to the test for refractoriness. It was suggested last year that we were wrong in specifying that the test sample should be treated without load, and that it should be under load. This is a matter that has received the consideration of the Refractory Committee. I am entirely sympathetic with such a suggestion; but the fact remains that, at the time we drew up the specification, there was no reliable information with regard to such tests anywhere. We have in Dr. Mellor a man who is certainly pre-eminent in the clay-working profession. There is no better man in this country. We went to the top of the tree, and Dr. Mellor's advice has been most valuable. His work on behalf of the Committee, and for the Committee, has been the most earnest and painstaking in every way. When Dr. Mellor tells us that no such information is obtainable of a reliable character, the Committee could not insert tests of this kind. Also, with regard to testing in a reducing atmosphere, it is perfectly certain that some retorts do have to work in a reducing atmosphere, and that a reducing atmosphere is more severe to the material than when testing in an oxidizing atmosphere. Here, again, we were working without information. It is a fact that all the large clay-testing laboratories in this country and, I think, in Germany specify that the tests should be of an oxidizing character; and the Committee could not specify something which it was most difficult to defend with this information at their backs. That is the reason for not specifying a reducing atmosphere, which undoubtedly would be rather more severe. I do not think, Sir, I have anything further to advance on this point. In conclusion, I should merely like to say the Refractory Materials Committee very keenly regret that they have this year lost their Chairman, Mr. J. W. Helps, who is retiring on account of ill-health, and also that Dr. Harold G. Colman, who should have been here this morning to move the adoption of the report, is prevented from doing so by an important professional engagement.

Mr. Edward Allen (Liverpool): I should like to second the proposition before the meeting. After what has been so well put by Mr. Bywater, I do not think that I need say very much. It will be quite clear to every one of us that the manufacturers, in attempting to improve the retorts, have gone rather too far in the direction of improving the porosity. It is the old story of "over-egging the pudding." You may do too much in an attempt to make things very good. It is gratifying, however—and I can speak from my own experience—that, while the retorts that were fixed two years ago at our works were not satisfactory in respect to the interior surface of them (they were too open, and there were too many fine cracks, and we had to be very careful when we were fixing them), last year the retorts supplied were much more satisfactory. We have had one year's work out of them; and we are quite satisfied the manufacturers are doing something to remedy any slight evils. The retorts supplied this year, we may say, are perfect in manufacture. They were made by the same firm. I am afraid some of us are prone to blame the retorts when we take liberties with them by not simply putting in a good charge of coal, but putting in something with the intention of improving the coke, by which the retort is caused to be subjected to influences which it is not expected to stand. I know of several such cases; so that before we put the blame on the manufacturer, we should ascertain the quality of the coal, whether there is much alkali in it, and whether what we put in to improve it has not some deteriorating influence on the fire-brick material.

The President: I have no doubt that several members will desire to speak to this report. I hope you will understand that I do not want to control unduly the action of individual members; but in the interest of the work that is before us, I want to ask those who wish to speak to-day to be as short as possible. I think that ten minutes should be amply sufficient for each person to express all that is necessary in the way of criticism of the papers; and those who can say what they have to say in five minutes will be rendering a great service.

Mr. W. B. Randall (Waltham Cross): I wish to thank the Refractory Materials Committee for this report, especially the Secretary, who has taken a great deal of trouble in the matter. He visited my works personally to go into the whole question. The point that I want particularly to emphasize is one that I mentioned last year, and is again mentioned in the report—namely, testing in an oxidizing atmosphere. I contend that, as long as these tests are conducted in an oxidizing atmosphere, they are fallacious for our purposes. If we take cone 28, and the actual temperature of our combustion chambers, there is a margin of 300° to 400°. I find that, since our meeting a year ago, we have set retorts which complied with the specification. But the retorts have melted; and the only way we can keep the nostrils of the combustion chamber from being absolutely slagged-up is by making channels on each side of the combustion chamber and taking out the slag material periodically. So I would ask the Committee to most carefully consider the question, because I think it proves absolutely that, if we give out a specification to manufacturers, and allow them to conduct tests in an oxidizing atmosphere, it is absolutely fallacious. Further, with reference to the

question of ascertaining the temperatures, I contend that Seger cones are not reliable. You can get all sorts of results with Seger cones; and the Committee are stultifying their own suggestion made five years ago, when they recommended a Féry optical pyrometer to ascertain the temperatures which were all tabulated. If we altered our standard in this way, first taking a pyrometer, which is the most accurate method, and then taking a Seger cone, we shall only get confusion worse confounded. In support of my views on the matter, I should like to mention that I sent samples of our materials, together with a specification, to the National Physical Laboratory, which is connected with the Royal Society; and their reply to me was as follows :—

May 9, 1913.

Dear Sir,—I regret that until there is a more definite understanding as to the methods to be adopted, and the standard improved for the measurement of the melting-points of material such as you mention, we are unable to help you.

You will agree that I am not speaking without some reason upon this subject. The whole gist of the matter is this: I have tried, as you, Sir, advised us yesterday, to get more gas every year, and, if you will allow me to add, from a smaller quantity of coal. In order to do this, I find if we increase our temperatures, we can increase our make of gas, without any question whatever. It has been very tersely put to me, Is the game worth the candle? I say unhesitatingly, "Yes." We are getting 15,000 cubic feet per ton; and if we can get the retort manufacturers to supply us with a better material, we should have a considerably greater make than this. I look to the Refractory Materials Committee to help me, and to help the industry generally, to obtain much better materials in future than we have obtained in the past.

Mr. George Helps (Nuneaton): My friend who has just sat down has raised a question in which I am greatly interested. I am very pleased indeed to have this opportunity of supporting a man like Mr. Randall in his remarks, because I think he has shown that he has some courage to come among us and tell us what he is doing in the way of heats. I must admit at once that I have never had any experience of such heats as he is using. He has told us that he is making 15,000 cubic feet of gas per ton, and this of itself is of sufficient note for us to inquire into. I take it that his chief point to-day is that the test which the Committee have specified is not sufficient for his particular requirements, though it may be sufficient for nine-tenths of us here. I think that this is a matter that the Committee might very well go further into, and give Mr. Randall the help he requires; or they might put something in the specification which would meet his needs.

Mr. Bywater: I do not think I have very much to say in reply, except to assure Mr. Randall—as he has most generously mentioned my name—that we are quite anxious to help him. But it must be obvious to all of you that Mr. Randall's standard is very high. I have never seen such heats myself. He infers that it pays him to burn his settings down; and if he cannot get material, that is his affair. If he finds his account on the right side—and he is the man to judge of that—then Mr. Randall is justified in working at the heats he does work at. But it is only fair to say that, if we fail to help Mr. Randall, he has failed to help himself. He cannot get anybody to supply him with the material. That is the *crux* of the whole thing. Where are you going to get the material from? That is the stone we have split upon all along. We have to supply you all with material, and that material has to be found in this country, if economical conditions are to be satisfied. It is quite easy to take the heat to an extravagantly high range, and get a lot of gas; but, after all, everybody cannot afford to renew his settings every year. As I have said, we are most anxious to help Mr. Randall; but there are a considerable number of difficulties in the way. With regard to his letter from the National Physical Laboratory, we have asked Mr. Randall to put us in communication with that body, and to specify what there is against us. But to this we have received no reply. As I have stated, gentlemen, the methods that we have adopted are those adopted in all large clay-testing laboratories everywhere. You cannot compare the people of the National Physical Laboratory—with all deference to them—with men of experience like Mr. Mellor, who has been in this business all his life.

The President: Since I asked Mr. Bywater to reply to the observations that were made on the report, it has occurred to me that Mr. Körting might be willing to say a word to us with regard to his personal observations.

Mr. Ernst Körting: In obedience to the request of your President, I am glad to tell you that when I was in the United States I was struck by the great extent to which silica material had been adopted. We all know that the ordinary time for carbonization in coke-ovens is about thirty hours; but since they have adopted silica in America, they have brought the time down to between fourteen and fifteen hours. The temperatures have been raised in the same way. I have seen in the Astoria Gas-Works in New York retorts made out of four or five pieces, which have kept their shape for three years—the only difficulty being that the material expands. They are put together in such a way that there is always a small space left between one piece and the next; and this is filled-in with thick paper. When the setting is put in, the paper burns, and the retort keeps its form satisfactorily. When it is cooled down, it contracts; and the sections become open, and are again filled up. I think it would be a good thing to use silica on this side of the water, when you take into consideration that the silica material stands a temperature of 1900° C., against 1500° C. of the other materials. The prospects of carbonization will be enormously changed for the better if you are thus enabled to use this higher temperature, which, of course, we can secure easily. I think it would be well worth the while of the whole gas industry to study this question very closely, to see if we cannot do the same as they are doing with such success in America.

The President: Mr. Searle, of Rochester, N.Y., knows a great deal about this matter; and I will ask him to kindly say a few words.

Mr. R. M. Searle (Rochester, N.Y.): I feel specially dignified in being allowed to appear before such a distinguished Institution, and particularly in that I am able to bring before you an improvement in our art which I believe is of great benefit to everyone. I might here say that I think you would be able to obtain the best information on this subject if you delayed your studies until the October meeting of the American Gas Institute, when the Carbonization Committee will report very elaborately on the silica materials used in the industries in the States. Mr. Russell, my colleague, who is with me touring Europe for information on the vertical retort question, recently made a tour with me covering some months in the States, studying the coke-ovens and horizontal retorts in use there. The work that the silica material does, and the improvement in the material itself, is so marvellous in its effect on the quality of the gas, as well as the amount produced, that it is worthy of consideration here. The coke-oven people have been able to carbonize a better coke in fourteen or fifteen hours with 15-ton ovens than they were able to carbonize in thirty hours with 10-ton ovens, making much better gas, and producing better coke for metallurgical purposes. We have one gas company in the States, which was the first to use the silica material, that is getting results so astonishing that the American engineer has his suspicions. Having been in the business, and having seen the evolution of it, I am beginning to come to the conclusion that when we adopt, as we shall, the vertical system in the States, we shall put in a number of vertical retort settings in silica material for our information and for that of others. The temperatures and the abuse that this material will stand, and the character of the material, from observation, is so diametrically opposite to what one would expect, having indulged for some years in the study of refractory materials, that I think you would say it is practically useless for retort practice. I have seen retort-pieces that you could crumble in your hand; and yet for three years they would take the jolt and the jar of operating machinery in horizontal and inclined retorts. The tests of the American Gas Institute will cover this point, and will determine, I think decisively, whether we have increased conductivity or radiation, or both, in the coal through this method of charging. We think that the conductivity is very rapid, and very efficient; and the heat is supplied much

more efficiently to the coal during the carbonizing period, allowing us to run horizontal retorts entirely full, whereas heretofore we had to have them, as you know, only about two-thirds full.

The PRESIDENT, in putting this resolution before you for adoption, I would like to call your attention to the following remark in the report: "It is obvious, however, that engineers should, either in collaboration with the manufacturers or independently, always have tests made, if they wish to ensure obtaining material of uniform quality." These ought not to be taken by an individual manager, but it should become the general practice to insist on having tests made. If we are not able to have the tests made in our own works, we should see that they are made before the material is passed. I think, gentlemen, that the report is one of the best examples that we shall have of the work of the Institution. I spoke yesterday of the admirable work that is being done by the separate Committees; and I think this report, and Mr. Bywater's presentation of it this morning, are evidence of the very best character of the work outside these annual meetings that the Institution is accomplishing. We shall be very glad indeed to have the results of the Refractory Materials Committee that are to be presented in October to the American Gas Institute; but I think we can assure our friend Mr. Searle that we are not going to wait till then, but shall push on and do what we can in the meantime. With regard to Mr. Bywater's observations, none of us will feel any concern whatever that the earlier results of the work of the Committee did not meet with complete success. Every departure of this sort is almost inevitably accompanied by temporary difficulties, and even failure; but to my mind the work as it stands now reflects the greatest credit upon the Committee. Those who are in favour of the adoption of the report will please to signify the same. On the contrary. It is carried unanimously.

The Papers.

The reading of papers was then proceeded with, in the following order:—

Wednesday.

"COKE-OVEN CARBONIZATION," by Mr. W. CHANEY, of Birmingham.

"LIQUID PURIFICATION," by Dr. W. B. DAVIDSON, of Birmingham.

"GASEOUS HEATING," by Mr. E. W. SMITH and Mr. C. M. WALTER, of Birmingham.

Thursday.

"CREATING AN OUTDOOR STAFF," by Mr. F. W. GOODENOUGH," of London.

"NOTES ON SUBURBAN GAS SUPPLY," by Mr. A. A. JOHNSTON, of Brentford.

The undermentioned two papers were also sent in for the meeting, but, owing to pressure of time, were not read or discussed.

"VENTILATION AND GAS," by Mr. S. B. LANGLANDS, of Glasgow.

"DEPRECIATION—ESTIMATED AND ACTUAL," by Dr. A. C. HUMPHREYS, of New York.

The papers, with full reports of the discussions which took place, will be found elsewhere in the "JOURNAL."

Communications Not Discussed.

The PRESIDENT: I have to announce with regret that Mr. Langlands has withdrawn his paper, in consideration of the shortness of our time and the number of our engagements to-day. Therefore, Mr. Langlands' paper, though it will be published, will not be discussed. We shall probably have to take the same course with regard to a paper most kindly prepared and forwarded to us by Dr. Humphreys, of New York. Dr. Humphreys wrote me saying that he would prepare a paper with pleasure, and he would come over to read it if possible; but he is just opening a new session of the Stevens Institute of which he is President, and he feared that he would not be able to do so. He asked me to put the paper last on the list, because this would increase the chances of his being present. I am quite sure he will not feel that we are wanting in respect to him if we leave his paper for publication. I commend it most cordially to you as worthy of your consideration.

THE BENEVOLENT FUND.

The annual meeting of the donors and subscribers to the Benevolent Fund was held on Wednesday morning. A report of the proceedings will be found on p. 997.

The New Officers.

The PRESIDENT announced the result of the ballot for the election of office-bearers for the ensuing year, as follows:—

President.—Mr. Edward Allen, of Liverpool.

Vice-President.—Mr. John Young, of Hull. [Mr. John Bond, of Southport, is the Senior Vice-President.]

New Ordinary Members of Council.—Mr. J. W. Auchterlonie, of Cambridge; Mr. J. C. Belton, of Chester; Mr. S. Y. Shoubridge, of Lower Sydenham; and Mr. W. W. Woodward, of Salford.

Auditors.—Mr. J. L. Chapman and Mr. E. W. Drew.

Hon. Secretary.—Mr. W. E. Price, Gas-Works, Hampton Wick.

New Members Elected.

The following candidates for membership, associated membership, and associates of the Institution were elected:—

MEMBERS.

Andrews, Arthur Herbert, Engineer and Manager, Gas-Works, Sittingbourne.
Blomquist, Edwin Ragnar, Chief Engineer, Municipal Gas-Works, Stockholm.
Brown, Robert Harry, Chief Assistant Engineer, Gas-Works, Birkenhead.
Bullmore, Alfred William Ernest, Resident Engineer and Manager, Gas-Works, First Garden City, Letchworth.
Carpenter, Augustus Arthur Norman, Engineer, Bow Common Works of the Gaslight and Coke Company.
Davies, Josiah Hartles, Engineer and Manager, Gas-Works, Church.
De-la-Motte, Freeman Alexander, Gas and Water Engineer, and Borough Engineer to the Conway Corporation.
Dixon, Henry, Engineer and Manager, Gas-Works, Conway.
Drewett, Percy, Manager, Gas-Works, Fareham.
Evans, Edward Victor, Chief Chemist to the South Metropolitan Gas Company.
Fligg, George William, Manager, Corporation Gas-Works, Dewsbury.
Ford, Robert William, Manager to the Vancouver Gas Company, Victoria Gas Company, and British Columbia Gas Company.
Goodman, Richard, Assistant-Engineer to the Brentford Gas Company.
Loveridge, Charles, Gas Engineer and Manager, Gas-Works, Wolstanton.
Lumb, Henry Dixon, Manager and Secretary to the Chard Corporation Gas Department.
M'Pherson, Charles, Engineer and Manager, Gas-Works, Clay Cross.
Matterface, Harold, Manager and Secretary, Gas-Works, Cinderford.
Mitchell, James, Engineer and Manager, Gas-Works, Montrose.
Mogford, John, Engineer and Manager, Gas-Works, Briton Ferry.
Okamoto, Sakura, Engineer, Gas-Works, Nagoya, Japan.
Porteous, William Vernon, Engineer and Secretary to the Wollongong Gaslight Company, New South Wales.
Purves, James, Engineer and Manager, Gas-Works, Ayr.
Roberts, William H., Gas Engineer and Manager to the Newtownards Urban District Council.
Robinson, Frank Herbert, Manager, Knutsford Light and Water Company.
Schieldrop, Bousak Kristian Gataas, Chief Engineer and General Manager, Municipal Gas-Works, Bergen.
Smith, Ernest Woodhouse, Chief Chemist to the City of Birmingham Gas Department.
Shapley, Charles Stuart, Superintendent of the Neepsend Gas-Works, Sheffield.
Wardell, Robert, Engineer, Gas-Works, Enfield.
Wilkinson, Hurdman, Engineer and Manager, Gas-Works, Slough.
Woodall, George Herbert, General Manager and Engineer to the Brooklyn Borough Gas Company, Coney Island, New York.

ASSOCIATE MEMBERS.

Bennett, Charles Valon, Assistant Engineer and Manager, Gas-Works, Dartford.
Clark, Harry, District Superintendent at the Potteries Station of the British Gaslight Company.

Cleator, John Gibson, Assistant Manager, Gas-Works, Cirencester.
Dillamore, Percy William, Manager, Gas-Works, Stanford-le-Hope
Higgs, Herbert Coldridge, Assistant Manager, Gas-Works, Basingstoke.
Jones, Samuel Gabriel, Assistant and Deputy Manager, Gas-Works, Burslem.
M'Minn, Stafford Alexander, Senior Assistant Engineer at the Beckton Works of the Gaslight and Coke Company.
Owen, William Henry, Superintendent Gas-Works, Hornsey.
Shepherd, Charles Edward, Assistant Manager, Gas-Works, Woking.
Tooth, Louis Frederick, Assistant Superintendent, Meter, Stoves, and Fittings Department of the Commercial Gas Company.
Twine, William Alfred, Superintendent of Chemical Plant of the City of Birmingham Gas-Works.
Vickers, Ramsay, Manager, Gas-Works, Bentham.

ASSOCIATE.

Paterson, Clifford Copland, in charge of the Photometric Department of the National Physical Laboratory, Teddington.

The New President.

Mr. EDWARD ALLEN (Liverpool): Mr. President and gentlemen, I have a very profound sense of the honour that you have conferred upon me; and I cannot feel unmoved at the manner in which my name has just been received by you. I am a "citizen of no mean city," and in respect of its gas undertaking Liverpool has been famous for very many years. I feel that I owe my position to-day largely because of that fame—a fame that has been made by my predecessors, the late Mr. Alfred King, who was so distinguished in our profession, and Mr. William King, whom I immediately followed. I feel very great diffidence in succeeding you in office; and all that I can offer to the members is the very best of my ability, and to say that I will devote as much time to the office as my other duties will permit. I want to say how much I have been influenced and charmed by the way in which my brethren have received me during the few years that I have been on the Council. Sir, there is nothing that has made my life more happy than the friendship that you have bestowed upon me. It is a wine that is exhilarating, and leaves no after bad effects. To meet you in London and elsewhere in a conference like this, or to meet you individually at my works or visiting your works, has always given to me intense pleasure. I am delighted to know that I may have an opportunity during the ensuing year of offering you my best service; and, with the assistance of the Vice-Presidents, whom I esteem so much, the Honorary Secretary, Mr. Price, and my friend Mr. Dunn, who always gives us of his best, I feel sure that in the great work of the Institution, with its allied interests, the British Commercial Gas Association, the Society of British Gas Industries, and the various Committees that will be dealing with most important matters, we may go forward with some degree of confidence, although we may speak with much diffidence. I thank you, Mr. President and gentlemen, most sincerely.

Next Place of Meeting.

Mr. H. WADE DEACON (the Chairman of the Liverpool United Gaslight Company): Mr. President and gentlemen, before I say what I have come here especially to say to you, I should like, with your permission, to be allowed to digress for one moment. First of all, I should like to offer my congratulations to Mr. Allen on his election as President of the Institution of Gas Engineers. I have known Mr. Allen for a great many years. We have worked together in a manner which I hope has been satisfactory to consumers of gas in Liverpool, as well as to the shareholders in the Liverpool Gas Company; and I congratulate him very heartily on his election to-day. I am sorry for him rather, in having to succeed your present President, because he is a man very difficult to follow; but I am quite sure from what I know of Mr. Allen that you may rely on his doing his best to follow in the steps of so distinguished a man.

In the next place, I wish to thank you for your courtesy in allowing me to sit here this morning to listen to the extremely interesting paper read by Mr. Goodenough, and the discussion that followed it. I am specially interested in the question on two sides. I am interested in it from the point of view of a Chairman of a Gas Company, and also from the fact that I happen to be rather an active member of the Education Committee of the County of Lancashire. Therefore you will see that I am interested in the question from an educational, as well as from a gas, point of view. It may interest some of you to know that at the present moment a great many of us on the Lancashire Education Committee are not satisfied with the results that have been produced for many years in the educational world. We have been making inquiries; and at the present time we are carefully considering this very question, and endeavouring to ascertain whether we are getting the results that we ought to get for the expenditure of our money. The question that has been raised to-day is of extreme interest to me. I should like to have several copies of the paper, so that I may send them to people who are interested in education; and I am quite sure that the discussion that has taken place will be of great value to me for what I may have to say in another place.

What I am specially concerned in now is to invite you, on behalf of the Liverpool Gas Company, to hold your next annual meeting at Liverpool. I understand that it is some 35 years since your meeting was held in that place. Those of you who were there at that time, if you visit us again, will find that considerable changes have taken place. Another generation has arisen in the 35 years; and there must be many men here who have never paid an official visit to Liverpool. On behalf of the Gas Company and the people of Liverpool, I extend to you a very hearty invitation to hold your next meeting in the city. I promise you that we shall make your visit interesting to you, and at the same time we shall get as much out of your brains as we can. I have much pleasure in inviting you to hold your next meeting in Liverpool.

The PRESIDENT: After the very kind words that have been addressed to us by Mr. Wade Deacon, I think, gentlemen, I shall have you with me when I propose that our next meeting be held in Liverpool. May I be permitted to utter a word of a personal character with regard to it? I was born in Liverpool. My earliest recollections of gas are associated with the name of Mr. Alfred King, who, when I was a young fellow in Liverpool, was the Engineer of the Liverpool Gas Company, and the most highly esteemed and respected man in the whole profession at that time. I have enjoyed, as Mr. King told you, I think, yesterday, the personal friendship of Mr. William King for a great number of years; and all the associations I have with Liverpool are so happy, and, especially with the gas undertaking, so full of respect and admiration, that I hope we shall unanimously resolve to make the acquaintance of Liverpool as it is and of its gas undertaking as it has been developed in the hands of those whom I have named and of our worthy and (shall I say?) beloved President, Mr. Allen. [Applause.]

Mr. ALEXANDER WILSON (Glasgow): I have much pleasure in seconding the proposition that our next meeting be held in Liverpool. It is always a pleasure for us in the Provinces to come to London; but I think to keep up an interest in the London meetings we require to have a meeting in the Provinces occasionally. Our last visit to Glasgow left such a good impression that most of you, I am sure, will have no difficulty in deciding to go to Liverpool and keep up the reputation of the Provinces there. I am sure that everything will be done in Liverpool as was done in Glasgow to make our visit not only instructive but enjoyable. The local authorities of the Provinces have a name for hospitality which is seldom obtained in London, because it is not possible to offer hospitality to all the Societies and Institutions that come here. In Liverpool you will get the attention of everybody, and, might I say, it will be a great advertisement in a way for the gas industry. I have much pleasure in seconding the proposal that our next meeting be held in Liverpool.

The PRESIDENT: In putting the resolution to the meeting, I need only say that we shall have great pleasure in going to Liverpool next year.

The resolution having been passed unanimously,

Mr. WADE DEACON said: Gentlemen, I am very pleased to see the unanimity with which the resolution was accepted. We shall be very glad to see you.

Mr. Belton Explains.

The PRESIDENT: Gentlemen, before we proceed to a very pleasant part of the proceedings on our programme, I have

to ask you to give attention to our friend, Mr. Belton, who is rather unhappy about the interpretation that appears to have been put on some remarks he made yesterday; and he wishes to make his position clear. I am quite sure that Mr. Belton will occupy only a few minutes; and I would ask that no comment be made on what he has to say.

Mr. J. C. Belton (Chester): I am very much obliged to you for giving me the opportunity to endeavour to remove what I believe to be a false impression of my remarks on Tuesday with reference to the question of the union of our three representative Institutions. The impression appears to have been conveyed to a great many of the members present at the meetings that the result of what I suggested would be the loss of the identity of our Institution of Gas Engineers, and, of course, equally so the loss of the identity of the other Institutions. I can assure you that such an idea was furthest from my thoughts. What I do feel, and what I believe the great majority of the members of our Institution feel, is that our position would be immensely strengthened by a combination of our forces. What we want is union without mutual absorption; and this is the whole of the idea as far as my suggestion goes. We want a National Gas Institute comprising the three Associations. The Institution of Gas Engineers would be one branch; the British Commercial Gas Association another; and the Society of British Gas Industries another. But all would form a National Gas Institute; so that we could present to those whom we wish to approach a united front of the whole of the interests of the gas industry.

My other idea was with regard to the provision of a home for our Society. Such a home could not be provided by any one alone of the three sections I have mentioned. It can only be provided by the combined effort of all three; and I say that this object can only be attained when we take the first step by uniting ourselves into a National Gas Institute. At present, the time is not ripe for the discussion here of such a suggestion; but I was most anxious that a wrong impression should not remain in the minds of the members to prejudice them against any further consideration of the question. I think, now that I have made my point clear, I would only add this remark—that, difficult as the matter may appear of accomplishment, it is not a *pons asinorum* which we cannot solve.

Honorary Members.

The President: Gentlemen, in accordance with the custom that has prevailed for some time past, I have the pleasure of proposing that the President of the Société Technique de l' Industrie du Gaz en France (M. Auguste Boutan) be elected an honorary member of the Institution. This is a reciprocal practice of ours, and, I think, a very happy one. May I remind you how cordial has been the message we have received from the Société during our meeting, and how very much we appreciate the presence of the gentleman deputed by them to represent the Society and to bring their messages of sympathy and congratulation to us? I refer to M. Robert Ellissen.

The resolution was passed unanimously.

The President: I have now an equal pleasure in proposing that Heer P. Bolsius, the President of the Dutch Association, who has been with us throughout our meetings, and who comes to us from a nation with whom we have been so closely identified—sometimes, perhaps, not in the most amicable way, but that was centuries ago—and a country to which we, as Englishmen, owe so much, in many ways, for all that they have done in the way of exploration, discovery, art, and so forth, and which, in the carrying out of the work of gas supply, has shown so many admirable examples of engineering in Amsterdam, The Hague, Haarlem, and elsewhere, be elected an hon-member of the Institution.

The motion was also passed unanimously.

The President: I also propose that Dr. Hans Bunte, the President of the German Association of Gas and Water Engineers, be elected an hon member of the Institution. Our German friends have been kindness itself throughout this meeting; and among all the pleasant incidents connected with it, that of the visit, for one short day, of our venerable and highly-esteemed friend, Dr. Hans Bunte, will be one that will remain in my memory as long as any.

The resolution was adopted *nem. dis.*

Votes of Thanks.

Mr. R. O. Paterson (Cheltenham): I have been requested to make a proposition to you, which I am sure will require no words of commendation from me to ensure that it shall receive from you the very highest recognition. We have, in our President, seen the very essence of a most amiable and efficient chairman of our meetings during this annual gathering; and I am sure it must be to the President himself a matter of very great satisfaction indeed to know that he has had, during the whole of these anxious days, the full, hearty, loving support of every member of the Institution. There is nothing that would give me more pleasure than to be able to convey to the President personally my own admiration of him. I have long known him; and when I first knew him (I will not say how many years ago, but it is a good many now), I looked upon him as a coming man. I think he has justified my expectation of him to the highest degree. I am sure we have all felt that the presidentship of the Institution during this jubilee year could not have fallen on shoulders more worthy than those of our esteemed President. He has acquitted himself to the utmost of our expectations, and we convey to him now our most devoted thanks and best wishes for a long-continued life and a continuously happy one.

There is one other matter, however, which I am also required to mention. We generally, in our annual gatherings, finish our business on the last day of our meeting, and the excursion follows practically as an inauguration of the new President. This year, by the kindness and courtesy of our President, and in conjunction with his amiable wife, Lady Woodall, we are invited to-morrow to his mansion in the heart of Kent. There, we shall have no opportunity of conveying to Sir Corbet and Lady Woodall our thanks; and it is right and proper that we should give those thanks in anticipation. I am sure you will all agree with me when I say that we wish to convey to Sir Corbet Woodall our very hearty thanks for his conduct in the chair, and to him and Lady Woodall for the hospitable entertainment which we are going to partake of and enjoy to-morrow. [Applause.]

Mr. T. B. Ball (Rochdale): It is quite a superfluous task for anyone to second a resolution such as the one which has been submitted to you. I am personally most glad to have the opportunity of associating myself with it. Those of us who have been spending their time at these meetings must have felt that it was no little tax upon their patience and upon their powers of endurance to follow at all closely the proceedings at these meetings; and I am sure that this must have been felt also by the President himself. I shall no doubt best consult his feelings, (and yours, too) by making my remarks as short as possible; and I will therefore confine myself to seconding the resolution which Mr. Paterson has submitted to you.

The resolution was passed unanimously, amid loud applause.

The President: Mr. Paterson, Mr. Ball, and gentlemen, I thank you very heartily, not only for this vote, but also for all the help you have given me throughout this meeting. I must confess I looked forward to it with a great deal of hesitation and fear; but from the opening of it until now you have made it a period, to me, of unqualified pleasure and enjoyment. These meetings are no doubt the cause, not only of anxiety, but of strain to the President during their continuance. That which I have felt most has been what I spoke of yesterday, when I said that we appeared to attempt rather too much. If I have shown (though I hope it has not been very much in evidence) any impatience at all during the course of the debate, I beg you to believe that it has only been from the earnest desire I had, and have had all through, that each paper should receive the amount of attention that its author was entitled to expect because of the pains and care he had taken in its preparation. There is one thing that has been a great trial to those attending this meeting, and

that is that our friends the railway people have not gone in for running silent trains. The interruption and annoyance caused by the passing of the trains must have been very trying to those who have spoken during the meeting.

I should just like to say a word or two with regard to our last meeting, when Mr. Shadbolt presided over us. It seemed to me, from what I saw of that meeting, that it was one of the most admirably conducted meetings I have ever attended in the whole course of my knowledge of the Institution; and I have felt that, in some way or other, we have a little lost sight of the obligation under which we were to Mr. Shadbolt, though, certainly, we did express it so heartily and thoroughly at the end of his year of office. With all my heart, I congratulate you upon the selection which has been made for the coming year. Mr. Allen does not need to be told that he has established a reputation among us that is of the most pleasant character; and I am sure that the personal affection that must be entertained towards him by all those who have come into contact with him is a very happy augury for the success of his year of office. I should like also to say how much I appreciate the work of the Council of the Institution. I believe that we have in the Council a body of men that can hardly be improved upon either within the ranks of the Institution or of any other society that I know of. These are no mere words of compliment. In all our Committees, I have been struck with the earnestness and thoroughness with which the work of the Institution is attended to; and this work has become, as I have remarked before, of a widely interesting and really useful character. I think that the constitution of the Council is one of the most encouraging things with regard to the future of the Institution.

The National Exhibition.

The PRESIDENT: Before I leave the chair, I may mention an incident that happened this morning, and one which I think will be of exceptional interest to the members. You know how intensely interested we all are in the success of the National Exhibition which will be held in October next. Now, if the exhibition is to be the success which it ought to be—and which we can make it—funds are of the very essence of the contract; and while the funds from the side of our friends the Society of British Gas Industries have come in as expected, there is some feeling of disappointment (and I confess that I share it myself) with the response from the gas undertakings, mostly the municipal, and also from some of the companies. I would ask all of you, in leaving this gathering, to make up your minds to do all you possibly can to ensure that the exhibition shall be really and truly a national demonstration, in the sense that it has been contributed to nationally. At the meeting of the Council this morning, which was especially called to consider a recommendation of the Finance Committee, it was decided that, in event of the necessity arising, the funds of the Institution should be devoted, up to, but not exceeding, £1000, as a second guarantee—that is to say, they are not to be called upon until the whole of the first guarantee is exhausted (if it ever becomes exhausted). But, for the encouragement of the Committee of the Exhibition, we are able to tell you the funds of the Institution will be drawn upon if necessary, within that limit. I may mention that the Institution receives as the collector (shall I say?) and, in some respects, as the representative, of the British Commercial Gas Association, between £400 and £500 a year for special purposes. Out of the Special Purpose Fund we were able, as you know, to contribute largely to the cost of the very successful defence of our interests as opposed to that of the alkali manufacturers in the last session of Parliament. It is from this fund that any draft will be made, should such a draft be found necessary. Personally, I believe that there will be no occasion whatever for calling upon it, as I do think—especially after their Majesties the King and Queen have recognized the value and importance of the exhibition by becoming its patrons—that we shall have no difficulty in finding the amount of money that is necessary for our purposes. [Loud applause.]

Further Votes of Thanks.

Mr. J. CARTER (Lincoln): A very pleasurable duty falls upon me, and that is to ask you to express your recognition of the services which the Council and the Hon. Secretary have rendered to the Institution during the past year. The President has just now given you his estimate of the strength and capacity of the Council he has been working with. It is an estimate no doubt formed after close and critical observation; and I think all I need do now is to assume that the President's estimate is exactly one that everyone of us entertains with regard to the capacity of the members of our Council. I am going to ask you to pass a vote of thanks to them for their very excellent services during the past year. If we are fortunate in having a Council that is thoroughly representative of all that is best of the gas industry of the United Kingdom, I am quite certain that we are equally fortunate in possessing the services of an Hon. Secretary whose name is an honoured one, whose tactful manner, coupled with a very genial disposition, I am quite certain have made duties that might otherwise be difficult a matter of very great ease. It is with very great pleasure that I ask you to accord to the members of the Council and our Hon. Secretary your heartiest thanks for their control and management of the affairs of the Institution during the past year.

MR. H. KENDRICK (Stretford): In seconding the resolution so ably put by Mr. Carter, I desire to associate myself entirely with the words that have fallen from his lips; and I will take up no further time in seconding the resolution.

The resolution was then passed unanimously.

Mr. J. P. LEATHER (Burnley): I have another proposition to lay before you that I am sure will be equally acceptable, and that is to propose that our hearty thanks be accorded to several sets of persons. In the first place, there are the Research Committees, which are a comparatively new part of our Institution's work. I speak as one who has been a member of this and the preceding Institution for a good number of years—going back I am not sure how far, but I think thirty years or more, when we used not to have Research Committees, though they were talked about for a great many years. Some members think, and they have expressed the opinion, that they do not do all they should do. But certainly they are doing something; and they are improving every year against difficulties. The next set of people to whom our thanks are due are the authors of the papers that have been read at this meeting. They have already each been thanked by the different persons who have spoken in the course of the proceedings; but we must not now omit them. Then the Scrutineers have certainly to be thanked. I remember acting as a Scrutineer in, I think, the year 1881 at Birmingham, and I had to leave the room, and had not an opportunity of listening to the address of Mr. Charles Hunt, who was our President that year. On that account I have always been thankful to the Scrutineers ever since. The fourth set of persons to whom our thanks are due are the Auditors. I do not know very much about their duties, as I have never acted in that capacity; but I feel that we must thank them for what they have done.

Mr. J. C. BELTON (Chester) seconded the resolution, which was passed unanimously.

The PRESIDENT: Now I have to propose that our cordial thanks be given to our Secretary. I have had to deal with a great many Secretaries, and not a few societies; but I have never met with anybody who is so freely at the service of the President, so constantly engaged in the work of the Institution as our friend Mr. Dunn. It has been an unqualified pleasure from beginning to end to have him associated with myself and the Council. I have therefore very great pleasure in proposing a vote of thanks to Mr. Dunn.

The resolution having been carried unanimously,

Mr. DUNN said: May I utter just one word, to say how very sincerely I appreciate what you have said with regard to my services, and the way in which the members have received your remarks? I shall always try to do the very best I can for the Institution and its interests.

The PRESIDENT: Gentlemen, that completes the formal business of the meeting.

PAPERS AND DISCUSSIONS.

COKE-OVEN CARBONIZATION.

By W. CHANEY, of Birmingham.

Considerable progress has been made on the Continent in the adaptation of the bye-product oven for the manufacture of illuminating gas. In this country, however, very little real attempt has been made to apply coke-oven gas for town lighting, though large quantities of surplus gas from coke-oven plants are utilized for the generation of electricity and steam pressure.

The principal objection hitherto raised was its varying composition and low illuminating power; and to some extent this, as well as other modern methods of carbonization, have been hampered by the restrictions prescribed by Parliament for the various methods of testing gas. In towns where the No. 1 argand burner is still applicable, the illuminating power of the gas by many of the modern systems of carbonization is such that the economies effected are in a measure counteracted by the enrichment necessary to meet the results obtainable with this burner. A slight alteration in the constituents of the gas—such as might be brought about by chamber oven carbonization—materially and unjustly penalizes the gas when tested with the No. 1 argand burner. These disadvantages are more than compensated for when either a calorific standard has been set up, or the No. 2 "Metropolitan" burner prescribed.

The Corporation of Birmingham recently had under consideration the remodelling of their carbonizing plant; and, bearing in mind the demand for furnace coke, their choice fell on coke-ovens. According to the statistics of the Home Office for the year 1911, the quantity of coke obtained from coke-ovens was about 11 million tons, and from gas-works about 7½ millions. In the case of furnace coke, everything is done to obtain the largest yield of coke having definite characteristics, whereas the gas-works practice is to obtain the largest volume of gas. Several installations were inspected in Germany and elsewhere, by Mr. Hilton, the General Manager of the Birmingham Gas Department, Mr. Bywater, and Dr. Davidson; and it was finally decided to recommend the adoption of Koppers' chamber ovens—these being specially designed both for the production of town gas and furnace coke.

A battery of twelve Koppers ovens, together with the necessary coal-stamping equipment, was put to work at Saltley in October last; and recently the Gas Committee have decided to increase this installation by a further 54 ovens, making 66 ovens in all. The ovens are heated by outside producers of the Mond gas type; and these producers, when the full battery is completed, will work under ammonia-recovery conditions.

The method of manufacture of Mond gas is well known; but as several points in its manufacture contribute to the economies of coke-oven plants as a whole, the author may be pardoned for briefly describing the process again. [A diagram of the plant is given in fig. 1.]

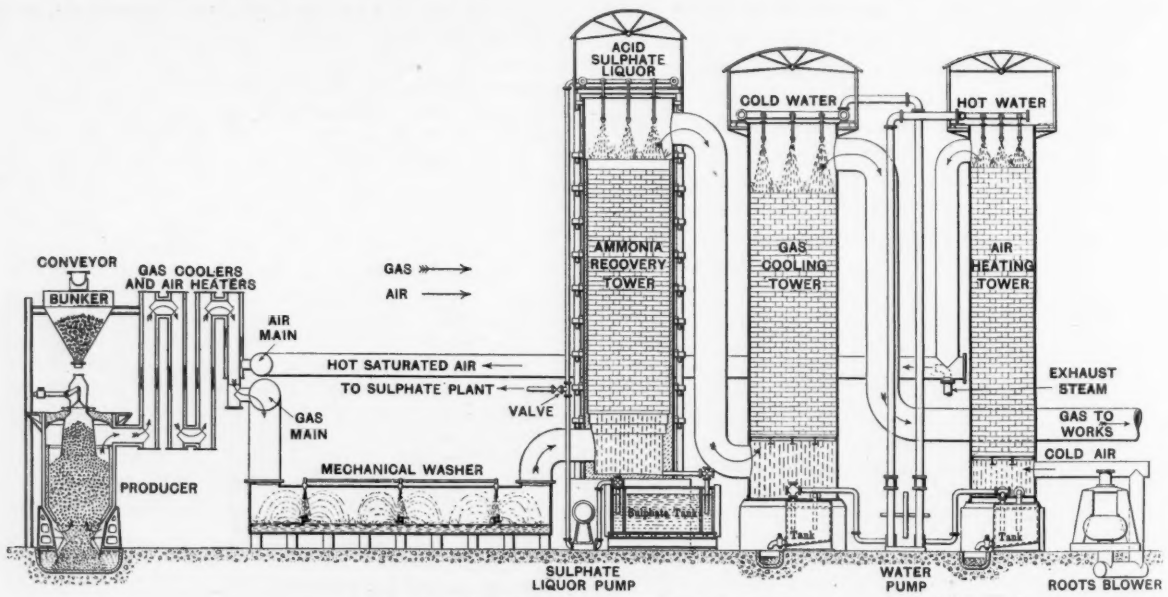


Fig. 1—DIAGRAM OF THE MOND GAS-PLANT.

The Producers.

The producer may be charged with either a mixture of coke, dust, small breeze, or coal slack of a suitable quality. The bottom of the producer is sealed in water, into which the ash descends, and is easily removed without interfering with gas making. A saturated blast of air is blown continuously through the producer, and by proper control of the temperature of saturation the formation of clinker is avoided; the ash from the fuel being the only residue. The gas on leaving the producer passes through a superheater, round which circulates the saturated air-blast on its way to the producer. The producer gas is conducted from the superheater direct to a mechanical washer, fitted with revolving "dashers," where it is washed with a fine spray of water, separating part of the dust and tar. From the washer the gas passes to the ammonia absorber, gas coolers, and finally through centrifugal fans and sawdust scrubbers, for the elimination of the last traces of tar, &c.

The Ovens.

The coke ovens are 35 feet long and 8 ft. 10 in. high; the average width being 18¾ inches, tapering from 18 inches to 19½ inches. They are heated by Koppers' regenerative principle of preheating both the producer gas and the secondary air. The regenerators are arranged under each oven, each oven having a separate regenerator divided into two sections by a partition wall C (fig. 2). The secondary air regenerators alternate with the gas generators A and B. On each side of the ovens are a series of vertical flues forming the combustion chamber E, also divided by a centre wall. The air A and the producer gas B flow through the chequer brickwork, meeting at the bottom of the vertical flue D; the products of combustion passing through the vertical flues E into the common horizontal flue G, over the centre division wall, down the corresponding flues on the other side, and through the regenerators into the main flue. By an ingenious arrangement of valves (fig. 3) connecting

each oven with a central change-over gear, the admission of secondary air and producer gas are reversed from one side of the oven to the other every half hour. By this arrangement the preheating of both the producer gas and the secondary air is effected.

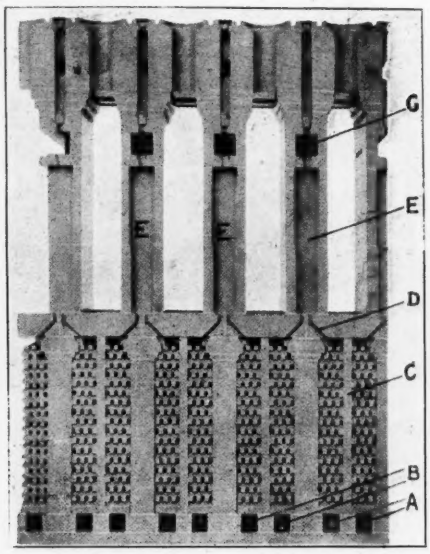


Fig. 2—Cross Section through the Ovens and Regenerators.

Particular attention is directed to the point at which the gas and air are caused to combine. It will be seen that the point of ignition is directly opposite the bottom of the charge, so that the greatest amount of heat is applied to that part of the oven being in direct contact with the coal—the sole and the crown not being subjected to an intense heat. By this means, a uniform heating is obtained, and coke cleaving in parallel lines is yielded.

The producer gas regulation (fig. 4) is effected by means of a gas-cock, the secondary air adjustment by thin strips of metal placed over the air intake, and each vertical flue is controlled by an independent damper. All the flues are accessible, and the temperature generally may be controlled with exactitude. The coal for carbonization is first broken to about 1¼ inches cube; and, to produce a dense furnace coke, it is further ground to a fine dust by means of disintegrators. The coal may be either charged into the ovens from a trolley running on rails along the top of the oven, or else it may be compressed into a solid cake by means of a stamping machine (fig. 5 and 6) and introduced through the end door of the oven.

Stamping and Charging and Discharging.

The stamping machine consists of a steel box, corresponding in size to the oven, travelling on wheels on the oven terrace. The disintegrated coal is compressed by means of a magnetic stamper, layer by layer, to the shape of the box, and it is then introduced into the ovens as a solid cake.

The doors of the oven are secured by a self-sealing device. They are of necessity heavy in construction, and are kept cool by water circulating round the frame of the door. No luting is required; and there is no tendency for the doors to warp.

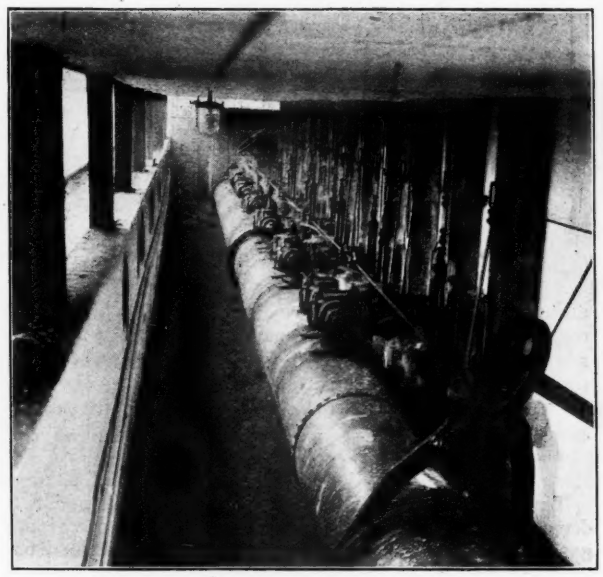


Fig. 4—Gas-Regulation Valves.

The coke is discharged from the oven by an electrically driven ram, into a "Goodall" coke-quencher. The quencher (figs. 7, 8, 9, and 10) consists of a frame running on wheels, and electrically driven. The frame carries a circular perforated platform corresponding to the level of the coke-oven, and may be made to rotate either clock or anti-clock wise. A "drop" plate connects the oven with the platform. The coke is pushed first through a "Darby" quenching hood on to the revolving platform, over which it is gradually and evenly spread. A series of pipes discharging high-pressure water are arranged round the "Darby" quencher and over the revolving platform. When all the coke has been discharged from the oven, the surplus water is allowed to

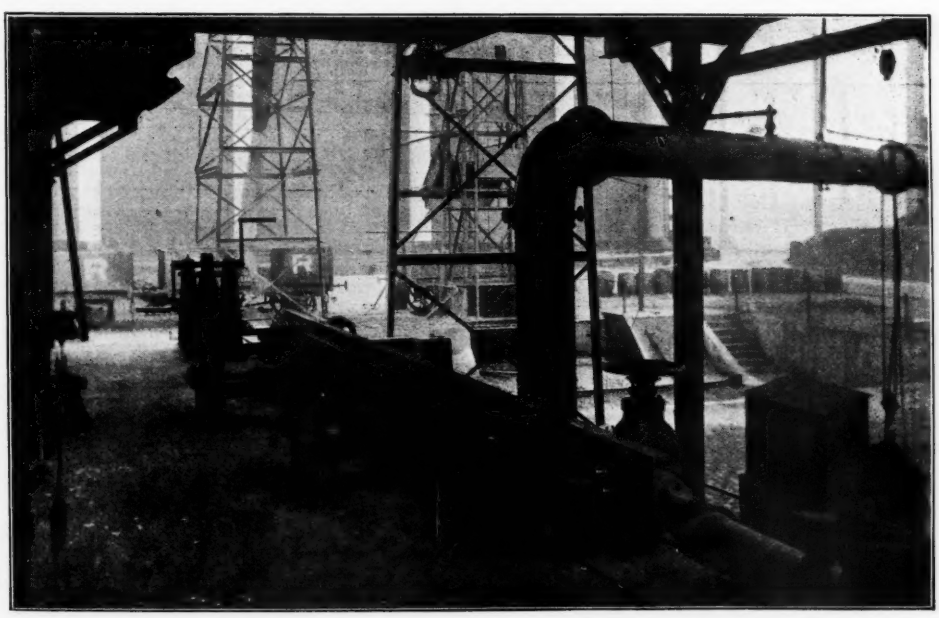


Fig. 3—CENTRAL CHANGE-OVER GEAR.

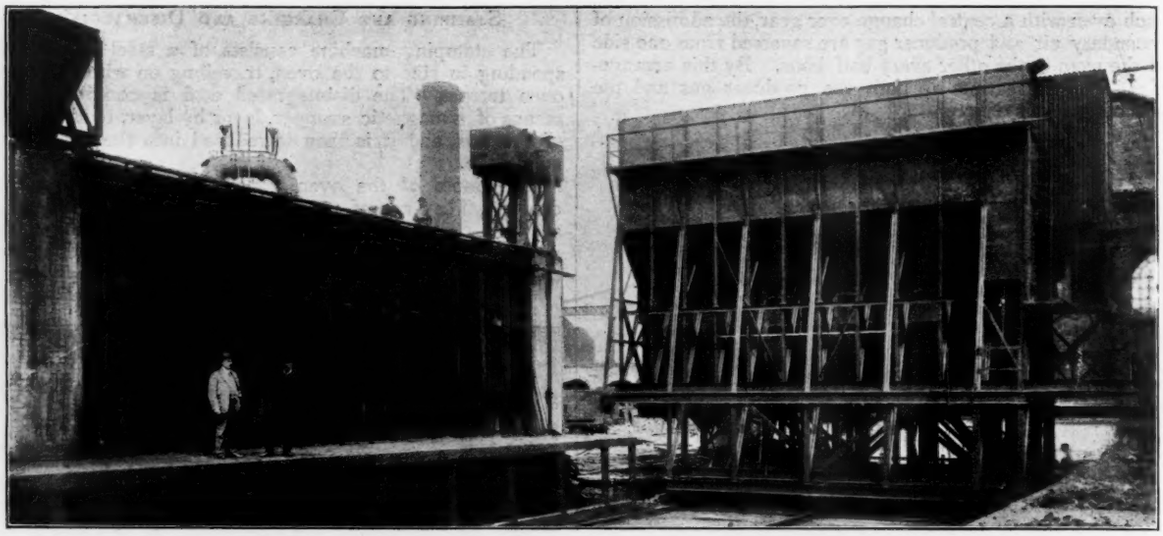


Fig. 5—THE CHARGING SIDE OF THE OVEN AND STAMPING MACHINE.

drain—usually a few minutes will suffice. The platform is then reversed, and a hinged door, forming part of the horizontal side of the quencher, is opened inwards towards the centre of the revolving platform, and so guides the coke over a jigging screen carried on the machine into railway waggons.

Gas Off-Take Pipes.

The gas off-take pipes from the ovens are connected to a dry collecting main. In this main the temperature of the gas is too high to allow of any of the water vapour condensing; and in order to prevent the deposition of pitch, a circulation of cold, thin tar is pumped through in a continuous stream. Suitable valves are arranged to shut off the oven from the main; and, in addition, a pipe connects the oven with the chimney stack, for the removal of the smoke while the ovens are being charged and discharged.

The Working of the Installation.

The heating of the trial installation at Saltley is effected by a single producer, working under non-recovery conditions, and without the necessary plant for efficient extraction of the tar and dust. This, together with the want of a small relief holder to store the gas while the change-over gear in connection with the ovens was being operated, militated against satisfactory results being obtained so far as fuel expenditure was concerned; the producer gas during the change-over period having to be blown away to the atmosphere, and the tar and dust causing leakage through the secondary-air and spent-gas valves.

The fuels first employed were a mixture of 50 per cent. small coal, about $\frac{1}{8}$ inch to $\frac{1}{2}$ inch in size, and 50 per cent. coke dust; the grading of the coke dust being as follows:—

	Per Cent.
Over screen 9 holes to the square inch	= 19
,, 16 ,, ,, ,, ,,	= 24
,, 36 ,, ,, ,, ,,	= 13
,, 64 ,, ,, ,, ,,	= 7
Through 64 ,, ,, ,, ,,	= 37
	100

The analysis of the fuels were as follows:—

	Carbon (Dry Basis). Per Cent.	Moisture. Per Cent.	Ash (Dry Basis). Per Cent.
Coal slack	73·0	10·6	4·5
Coke dust	79·7	6·2	13 4

Average calorific value of mixture = 12,280 B.Th.U. per pound of fuel dry.

Unfortunately, after a few days' working with this mixture, clinkering troubles developed; and only having one producer to rely upon, it was abandoned. From the general results obtained, it would appear possible to use coke dust and coal slack; but the fuels would be better gasified in separate producers. The average calorific value over an extended period was 130 B.Th.U. per cubic foot net. The producer was then charged entirely with small coal, and

Cost of Heating Coke-Ovens, Outside Producers, with Ammonia Recovery.

—	Uncompressed Coal.		Compressed Coal.	
	All Coal Slack.	50 Per Cent. Coal Slack. 50 Per Cent. Coke Dust.	All Coal Slack.	50 Per Cent. Coal Slack. 50 Per Cent. Coke Dust.
	12 Per Cent. of Fuel on Coal Carbonized.	12 Per Cent. of Fuel on Coal Carbonized.	15 Per Cent. of Fuel per Ton of Coal Carbonized.	15 Per Cent. of Fuel per Ton of Coal Carbonized.
	Per Ton of Coal Carbonized.	Per Ton of Coal Carbonized.	Per Ton of Coal Carbonized.	Per Ton of Coal Carbonized.
	d.	d.	d.	d.
Small coal, at 10s. per ton	14·40	7·20	18·00	9·00
Coke dust, at 1s. 6d. per ton	..	1·08	..	1·35
Boiler fuel: 50 per cent dust, at 1s. 6d.	0·33	0 33	0 36	0·36
Boiler fuel: 50 per cent. breeze, at 7s. 6d.	1·64	1·64	1·79	1·79
Labour	3·28	3·28	3·84	3·84
Repairs, Maintenance, Depreciation, Interest — 20 per cent.	7·29	7·29	8·53	8·53
Oil and waste	0·29	0·29	0·34	0·34
Acid, at 30s. per ton	1·56	1·04	1·95	1 30
Bags and packing	0·36	0·24	0·46	0·30
	29·15	22·39	35·27	26 81
Sulphate recovered, at £13 per ton	15·05	10·02	18 81	12·52
Total cost of heating per ton of coal carbonized	14·10	12·37	16·46	14·29

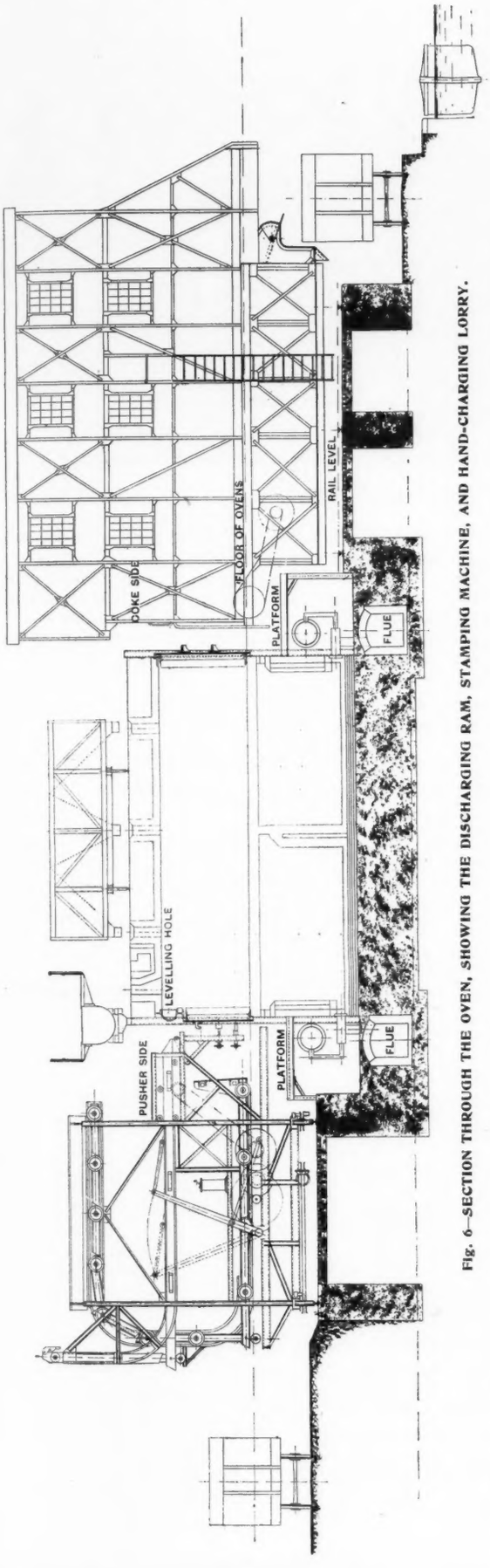


Fig. 6.—SECTION THROUGH THE OVEN, SHOWING THE DISCHARGING RAM, STAMPING MACHINE, AND HAND-CHARGING LORRY.

worked under non-recovery conditions. The average percentage analysis of the gas produced was as follows:—

	Per Cent.
Carbonic acid	9·5
Oxygen	0·3
Hydrocarbon	0·3
Carbonic oxide	20·0
Hydrogen	17·8
Light carburetted hydrogen	2·8
Nitrogen	48·9
Sulphuretted hydrogen	0·4
	100·0

Analysis of fuel. . . . . water, 10·0 per cent.
Ash . . . . . ash, 5·4 ,, ,,
Fuel consumption 15·73 per cent. of combustibles on the raw coal carbonized.

B.Th.U. per cubic foot net	147
Approximate yield of gas per ton of fuel	130,000 cubic feet
Temperature of blast saturation	159° Fahr.
,, ,, gas at outlet of generator	1100° ,,
,, ,, chamber oven	1922° ,,
,, ,, waste gas	420° ,,
,, ,, producer gas entering ovens	66° ,,

Analysis of waste gas—

Carbonic acid	14·1
Oxygen	1·8
Carbonic oxide	*nil*

Ashes from producer—

	Per Cent.
Moisture	18·1
Combustibles	2·0

The high percentage of fuel used was influenced by the circumstances previously mentioned. Some figures recently published of a similar installation at Vienna give the fuel consumption as 10 per cent. on the coal carbonized; the producers being charged with coke dust and small breeze, and worked under non-recovery conditions.

Assuming that 12 per cent. of fuel is consumed per ton of coal carbonized in the ordinary method of heating retorts, it is questionable whether this figure may be reduced by outside producers, working under ammonia recovery conditions. On the contrary, unavoidable losses of sensible heat by radiation and conduction all of them tend to increase the fuel expenditure. But the recovery of ammonia, the employment of inferior fuel, and the liberation of coke, are economies to be considered in the adoption of outside producers.

On the statement [p. 940], the author has set out the cost of fuel per ton of coal carbonized with outside producers under recovery conditions, using small coal alone and mixed with equal quantities of coke dust.

Cost of Heating Retorts by Regenerative Furnaces, Based upon 12 per Cent. of Fuel per Ton of Coal Carbonized.

	Per Ton of Coal Carbonized. d.
Coke, at 14s. per ton	20·2
Labour	2·7
Repairs to furnaces, stokers' tools, and depreciation	1·0
Total cost of heating per ton of coal carbonized	23·9

The approximate value of the nitrogen content in the dust being 1 per cent., and in the coal slack 1·4 per cent., an adjustment for the sulphate of ammonia recovered on this basis has been made. The value of the coke that is liberated by the use of outside producers is appended to the same statement, as is also the cost of heating retorts by the ordinary regenerative method. The quantity of air required for the combustion of 100 volumes of Mond gas is approximately 120 volumes of air; and this lends a very easy means of adjustment.

Other economies effected by the use of outside producers is the generating of electric current. For a plant similar in size to the extended Saltley installation, about 400 kilowatts per hour is necessary. For the production of the producer gas, approximately 2½ lbs. of low-pressure steam are required for each pound of fuel gasified under recovery conditions. This steam may be first utilized for driving the alternators generating the current; the exhaust steam passing to the blast-mains for saturation purposes. With due allowance for depreciation, maintenance, and other charges, the cost of producing current by this means works out at approximately 0·3d. per unit.

Selection of Coal.

As regards the selection of coal for the ovens, an expanding coal is not desirable, owing to the difficulty of discharge;

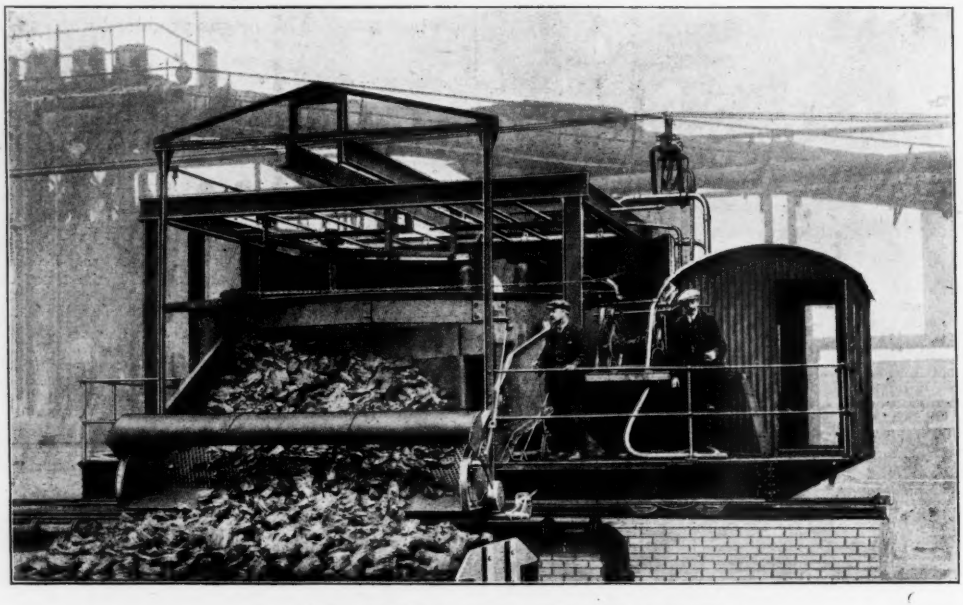


Fig. 7—THE GOODALL COKE-QUENCHING MACHINE.

the sulphur and ash content are also important factors, as is also the amount of alkali. This latter objection is no doubt as applicable to the ordinary retort, but perhaps not so much appreciated. Many oven builders, in giving guarantees, protect themselves by limiting the amount of sodium or potassium chlorides in the coal to be used to one gramme of sodium or potassium chloride per litre of water. The influence of the alkali salts has a very important bearing upon the life of the oven walls; and in many instances repairs to the same have been necessary after only a few months' working when the coal employed has been heavily charged with salt. Many of the coals from certain Midland districts are poor in caking qualities; and to produce a hard furnace coke compression is necessary. Such coals contain in their raw state from 4 to 7 per cent. of water, which content has to be increased to about 12 per cent. when stamped. The period of carbonization for stamped coal is about thirty hours; and for unstamped coal, twenty-four hours. The coke produced from the two methods (as will be seen from the samples exhibited) differs very greatly, physically.

First sample—Coal nuts about 1¼ inch cube, charged into oven through top doors.
Second sample—Coal nuts disintegrated, but unstamped, charged into oven through top doors.
Third sample—Coal nuts disintegrated, stamped, and charged with stamping machine.

The working of the installation for the first few months was naturally more or less of an experimental nature; the primary object being to ascertain how the illuminating power and the calorific value compared with other modern systems. The following figures were obtained from a mixture of 50 per cent. South Yorkshire coal, and 50 per cent. of Derbyshire coal unstamped.

Duration of test	7 days
Number of ovens charged	84
Gas made, corrected for temp. and bar. (CO_2 not removed)	8,219,000 cubic feet
Coal carbonized (raw)	650·35 tons
Analysis of coal—	
Water	4·0 per cent.
Ash	4·5 ,, ,,
Gas made per ton of coal, corrected for temp. and bar.	12,640 cubic feet
Illuminating power, No. 1 burner (CO_2 not extracted)	14·05 candles
Illuminating power, No. 2 burner (CO_2 not extracted)	17·00 ,,
Calorific value	500 B.Th.U. net per cubic foot
,, multiple	6340
Specific gravity of gas	0·437

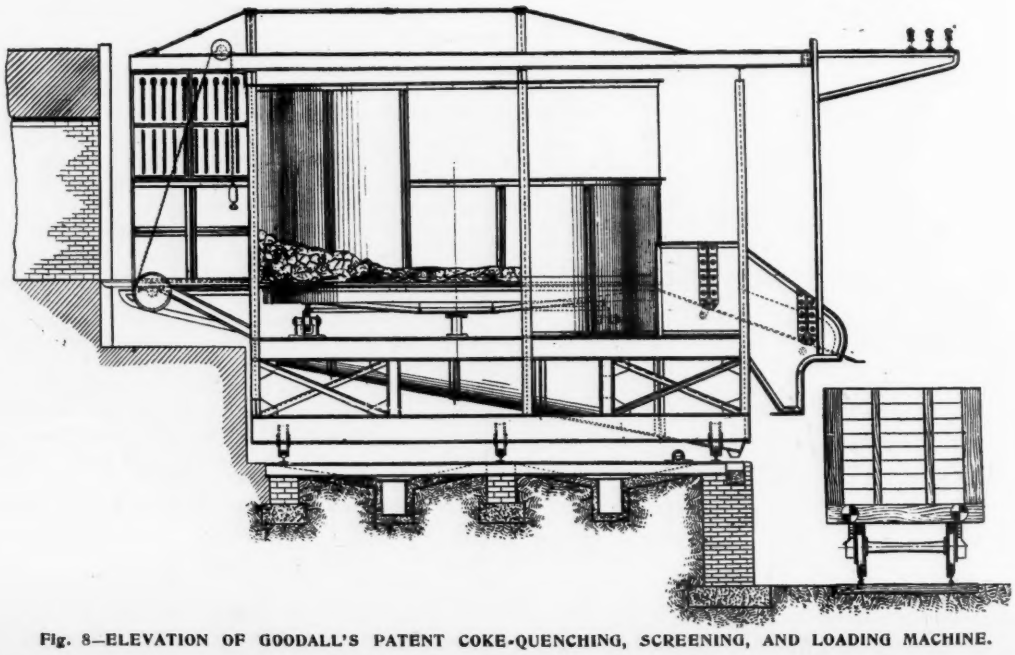
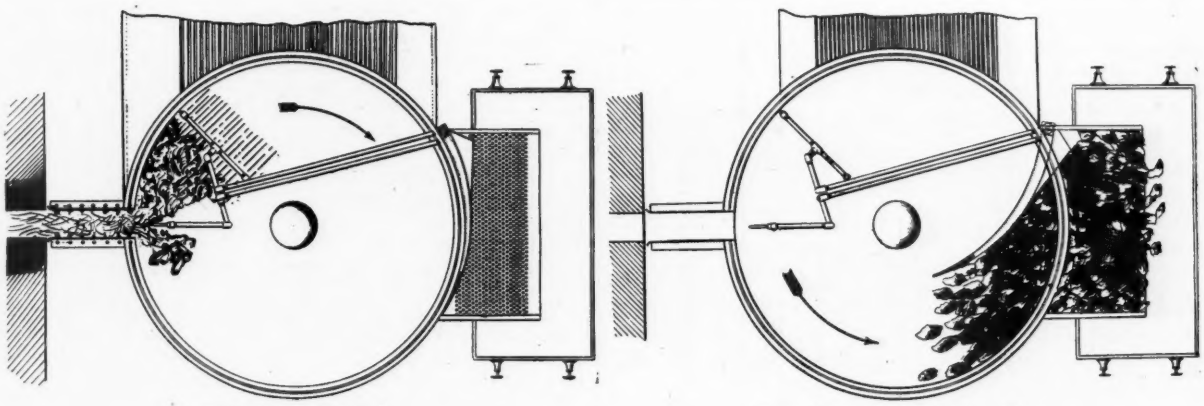


Fig. 8—ELEVATION OF GOODALL'S PATENT COKE-QUENCHING, SCREENING, AND LOADING MACHINE.



Quenching Operation. Screening and Loading Operation.

Figs. 9 and 10—GOODALL'S PATENT COKE QUENCHING, SCREENING, AND LOADING MACHINE.

Analysis of Gas.

	Per Cent.
Carbonic acid	2·1
Hydrocarbons	2·9
Oxygen	0·7
Carbonic oxide	7·8
Hydrogen	50·0
CH_4	30·0
Nitrogen	6·5

Sulphur in gas, other than H_2S, 30·7 grains per 100 cubic feet.
Cyanides as $Na_4 Fe (CN)_6$ 3·34 lbs. per 10,000 cubic feet.

Tests of Gas. Daily Average of Three Samples, each Collected over a Period of Eight Hours.

UNSTAMPED COAL CHARGES.

50 PER CENT. SOUTH YORKSHIRE, AND 50 PER CENT. DERBYSHIRE COALS.

Date. 1912.	Calorific Value.	Illuminating Power.		Temperature of Ovens.
	B.Th.U. Net.	No. 1 Argand.	No. 2 Argand.	
Nov. 22	508	14·08	16·95	1043
,, 23	509	14·68	17·23	1045
,, 24	479	13·03	15·38	1032
,, 25	501	13·67	16·57	1043
,, 26	503	14·48	18·03	1072
,, 27	506	14·22	17·27	1064
,, 28	507	14·23	17 63	1075
,, 29	490	13·68	16·53	1060
Average	500	14·00	17·00	1054

Owing to the arrangement of the wells at the Saltley Gas-Works, it has not been possible to isolate the tar and liquor produced; but the yield of liquor appears to be quite equal to that obtained by other systems of carbonization, and certainly larger than is obtainable where stoking machines and horizontal settings are employed with a single ascension pipe.

The tar produced gave an analysis as follows:—

	Per Cent.
Light oils up to 170° C.	24·9
Creosote oils	25·9
Heavy oil	9·3
Above 270° C.	11·4
Pitch of total	28·0
Free carbon in tar	3·5

The coke, as previously described, is handled by means of a "Goodall" coke quencher. The quenching is quick—a necessity with oven coke, the fine colour and lustre being largely due to the result of rapid cooling; and with care the percentage of water may be reduced to an average of not more than 1 to 2 per cent. The coke is delivered over a "jigging" screen attached to the quencher directly into railway waggons. By this means the labour costs of coke handling and the breakage due to conveying and screening plant are considerably reduced.

Percentage of Coke, Breeze, and Dust Made, per Ton of Unscreened Coke.

	Coke Screening and Conveying Plant. Inclined Retorts.				Coke-Ovens. "Goodall" Quencher.			
	Per Cent.	C.	Q.	L.	Per Cent.	C.	Q.	L.
Coke	74·6	14	3	19	87·7	17	2	4
Breeze	16·1	3	0	25	9·4	1	3	15
Dust	9·3	1	3	12	2·9	..	2	9
		20	0	0		20	0	0

With the stamped charges, the coke is, of course, too dense for other than furnace work, and much is dependent upon the local demand for same. The coke produced from the hand-charged ovens, although much more dense than ordinary gas coke, is suited for ordinary purposes, and it is only a matter of creating a demand for the improved material. The specific gravity of the coke from coal nuts charged into the oven without disintegration equals 1·59; or disintegrated and compressed, 1·81. The price of furnace coke in Birmingham at the present time is several shillings in advance of gas coke. The cycle of power required for the various operations of stamping, charging, and discharging one oven (capacity 9 tons) is given in fig. 11; the total time for charging and discharging being 15 minutes per oven.

LABOUR AND REPAIRS COSTS.

The installation at Saltley has not been running sufficiently long, and the unit is too small, to put forward definite figures as regards the cost of labour and repairs. The repairs are facilitated by shutting-off the producer gas from the individual oven to be dealt with, and without shutting-down a whole battery at one time. The allowance for expansion of the brickwork is well adjusted; and there has been no trouble through leakage, &c. It is estimated that the life of the oven should be about six years, and that the cost of repairs should not exceed 3d. per ton of coal carbonized.

As regards labour, with the full 66 ovens, two complete sets of machines will be installed—*i.e.*, two pushing rams, two stamping machines, and two quenching machines. The compressed charges of 30 hours' duration, will necessitate discharging eight to nine ovens per shift, per machine, or 22 ovens with uncompressed coal, per shift.

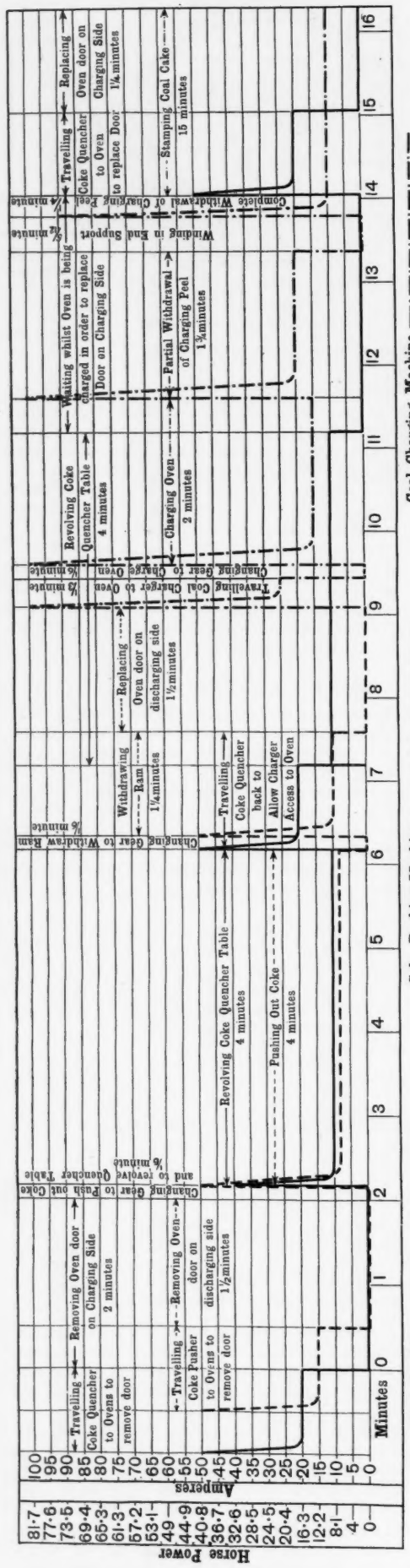
Estimated Labour Costs.

Coal to Crushers. Coke to Railway Waggons.	Stamped Charges. Per Ton of Coal.	Unstamped. Per Ton of Coal.
	d.	d.
Machinemen, Gas regulator men, Tar attendant	3·9	3·1
Coal unloading	1·0	0·8
Odd men	2·4	1·9
Total	7·3	5·8

Excluding men employed upon Mond gas plant.

In comparing these figures with other systems of carbonization, it must be borne in mind that they cover the complete handling of the coal and coke from the arrival of the coal at the gas-works to the loading-up of the coke into railway waggons for sale.

The arrangements of the stamping machine and discharging ram at Saltley are somewhat different from the usual method employed. It is the common practice to charge and discharge the oven from one side only—both operations being performed by one combined machine. The ovens at Saltley taper from 18 inches to 19½ inches at the opposite end; the coal being introduced at the widest end, necessitating the employment of an extra machine—the pushing-ram on one side (the narrower end) and the charging-machine on the opposite side. Although slightly


Horse Power
Amperes
Minutes
Quenching Machine
Coke Pushing Machine
Coal Charging Machine
Travelling — Coke Quencher to Ovens to remove door
Removing Oven door on Charging Side 2 minutes
Travelling — Coke Pusher to Ovens to remove door
Removing Oven door on discharging side 1½minutes
Changing Gear to Push out Coke and to revolve Quencher Table ½ minute
Revolving Coke Quencher Table 4 minutes
Pushing Out Coke 4 minutes
Changing Gear to Withdraw Ram ½ minute
Withdrawing Ram 1¼minutes
Travelling — Coke Quencher back to Allow Charger Access to Oven
Replacing Oven door on discharging side 1½minutes
Changing Coal Charger to Oven ½ minute
Travelling Changing Gear to Charge Oven ½ minute
Revolving Coke Quencher Table 4 minutes
Charging Oven 2 minutes
Waiting whilst Oven is being charged in order to replace Door on Charging Side
Partial Withdrawal of Charging Peel 1¾minutes
Winding in End Support ½ minute
Complete Withdrawal of Charging Peel ½ minute
Travelling — Coke Quencher to Oven to replace Door
Replacing — Oven door on Charging Side 1¼minutes
Stamping Coal Cake 15 minutes

Time occupied—from removing the oven door on the charging side to replacing same, after the oven has been discharged and charged (without any time allowance for the travelling machine) = 14¾ minutes.
Time occupied in stamping coal cake = 15 minutes. One oven, say, every half-hour.

Fig. 11.—INSTALLATION OF TWELVE KOPPERS' CHAMBER OVENS AT THE SALTLEY GAS-WORKS, BIRMINGHAM.
Diagram showing the cycle of time and power required to discharge and charge one oven. Alternating current, 440 volts; phase, 25 cycles.

increasing labour costs, the charging and discharging are facilitated, and the charge of coal into the oven increased.

The coke quenching, screening, and loading costs are considerably reduced; the "Goodall" machine being designed to meet all these conditions in one operation. The customary method of pushing the coke from the oven on to a sloping concrete terrace, and then dealing with the material by hand, necessitated the employment of a number of men for quenching and loading purposes; and, in addition, much breakage, due to the intermediate handling between the oven and the waggon, is now avoided. The "Goodall" quencher performs all these operations with considerable saving of labour and increased yield of coke.

The self-sealing doors of the ovens, although somewhat heavy in initial capital outlay, dispense with the labour of the door "setters" and "dawbers" usually employed in securing the doors from leakage by means of clay.

The tendency of leakage through the joints of the brickwork forming the oven walls is not more than with ordinary retorts; and the large doors of the self-sealing description closing the ends of the oven are as efficient as the ordinary retort-lid. Speaking generally, by maintaining a slight *plus* pressure on the ovens, the carbonic acid and nitrogen content in the gas may be kept well under control.

The coal usually employed in the bye-product oven is washed slack; the original material containing varying quantities of foreign matter. The quantity of ash contained in the resulting coke, within certain limits, does not appear to materially affect its market value. A recent analysis of one of the best Durham cokes selling in Birmingham at many shillings per ton in advance of gas coke yielded on analysis 8·4 per cent. of ash; while one of the cheapest Derbyshire cokes, much less in price, gave, on analysis, slightly less ash—the total sulphur in both cases being almost identical. The actual value of a furnace coke seems to be more or less governed by the working experience of the ironmaster, and there appears to be no standard method of comparing the density of the coke, in order to fix its market price. With the coke-oven, as with the gas-retort, high temperatures are essential both for the production of hard furnace coke combined with a high yield of gas per ton of coal carbonized; and providing the oven is uniformly heated, it does not appear that the illuminating gases are broken-up to any serious extent.

The question of the temperature of carbonization does not materially influence the coke-oven manager. For the production of dense coke it is, however, necessary that the whole of the volatile matter from the coke be driven off. The temperatures usually employed by coke-oven managers are much lower than those that are adopted for a high yield, as with gas-retorts; and the period of carbonization is consequently prolonged. It is during the end portion of this period that air is drawn into the bye-product oven, and the composition of the gas thereby affected. Coke-oven units are of necessity large—the charge per oven being from 8 to 10 tons; so that their applicability is limited at present to towns where the fluctuation of the consumption of gas comes within this range.

The author has not been able to institute a comparison between the coke-oven and the various modern methods of carbonization, his aim being to place before the Institution such information as would clear the ground for the consideration of the adoption of the coke-oven as a practicable method for the utilization of the surplus gas from the bye-product oven, and also its utility as an economical method of carbonization as applied to gas-works.

DISCUSSION.

The PRESIDENT: In inviting discussion on this most interesting paper, I might mention that fourteen gentlemen have, in accordance with the rule we adopted, sent in their names as wishing to take part in the discussion. Fourteen multiplied by five comes to seventy. That is an hour and ten minutes; and we must leave some time for Mr. Chaney to make his reply. I beg, therefore, those of you who are not keen about speaking to refrain from doing so, and those who do speak I would ask to make their observations as short as possible.

Mr. J. W. MORRISON (Sheffield): Our thanks are due to the Birmingham Corporation for testing this important system of carbonization. It seems to me that Mr. Chaney in his paper has omitted the most important factor to most

of us—namely, the cost of the installation. I understand from some inquiries I made that the cost is somewhere about £170 to £180 per ton of coal carbonized, which is about 100 per cent. more than I spent on a 5-million cubic feet plant two or three years ago. That to a company is a most serious consideration, and entirely blots out any prospect of putting down such a carbonizing system. Capitalizing the extra cost on a 5-million cubic feet basis, I put it down roughly at between £36,000 and £40,000 for the installation, which, worked out at cost per ton, working 250 days per annum, and carbonizing 420 tons, is roughly over 1s. per ton of coal. The labour charges Mr. Chaney puts down at 7·3d. per ton of coal for stamped charges; but this, of course, includes the cost of coke loading. That is very satisfactory, so far as it goes; but Mr. Chaney cannot, I think, rely on putting all the coke he makes direct into his trucks. The coke market is at the present time in a very unsatisfactory state. In Yorkshire, where these ovens have been largely adopted, the market has been flooded with this class of coke; and it is now a very important competitor with gas-works produce. The coke-ovens in some cases have been shut-down with the idea of curtailing the supplies. If this system were adopted for gas-works practice, we could not do the same; we must keep going. Mr. Chaney mentions that two years ago there were 11 million tons of coke produced by this system of carbonization, compared with 7½ millions from gas-works. During the last three years, I should think there must have been within fifty miles of Sheffield some hundred plants put down.

The PRESIDENT: Might I suggest that these observations are hardly germane to the paper, because what Mr. Chaney is introducing to us is a method of using coke-ovens on gas-works in replacement of ordinary plant.

Mr. MORRISON: When you are considering laying out new works, I submit that these are considerations you have to take into account.

The PRESIDENT: The only point was that the amount of coke made in coke-ovens outside does not affect the discussion on this paper.

Mr. MORRISON: I thought it did, because in laying out new works we must take into consideration how we can dispose of the products. I should like to thank Mr. Chaney for his paper.

Mr. J. FERGUSON BELL (Derby): I think the Birmingham City Gas Committee are to be congratulated, along with their responsible advisers, for their enterprise in the erection at their Saltley works of an installation of Koppers' chamber ovens; but I would point out that if there is one town in England where there is a demand for this coke it is Birmingham, the centre of the hardware trade. From what I could gather from the paper, the author's object in introducing this system, which has been largely adopted on the Continent, is that he will get an improved market for his coke. I obtained from a large Derbyshire coke manufacturer who makes hard coke the average price they had secured for the last five years; and on comparing this with the average price at Derby, I see there is only a difference in favour of the hard coke of something like 5d. a ton. I do not think that it is a good way to gasify coal in coke-ovens, because you must remember that, as the author has pointed out, the coke-ovens make a solid residue. In gas-works, of course, we go in for gaseous products. The question that Mr. Morrison raised is, I think, a very important one—namely, as to the capital outlay. The author does not, in his paper, go into this matter; but from what I could gather, the installation he refers to must have been a very costly one.

I rather question the economic advantages of introducing further complications into gas-works by a large Mond plant. This must entail an extra amount of work; and I see the figures that the author quotes are rather large, because he says that he requires a fuel consumption of 15¾ lbs. per 100 lbs. of coal carbonized, which is rather large. In a Mond plant you must remember that there are 2½ tons of water to be evaporated per ton of coal gasified; and this must entail very considerable cost. The figures given by the author, of 12,640 cubic feet of gas for 500 B.Th.U. from 50 per cent. of South Yorkshire coal and 50 per cent. of Derbyshire coal, do not seem to be very high figures, and do not compare with gas-works practice. Then there is the question of economy of labour. What with the introduction of machinery and vertical retorts, the labour cost has been reduced by from 6d. to something like 1s. per ton of coal carbonized. All these are questions that want to be very carefully considered by anybody introducing this system. Then I apprehend that it is only in places far removed from a populous district where it would be possible to employ such a plant as this without causing a very serious nuisance to the adjoining property. I beg to thank the author for his paper, which I have perused with very great pleasure.

Mr. F. J. BYWATER (London): I am very pleased to be allowed to say a few words on this paper, because the scheme was one for which I was happy to accept a considerable amount of responsibility. It is one of the legacies that I left Mr. Chaney when I went from Saltley. There were not, I hope, very many unhappy ones. It gives me great pleasure to thank Mr. Chaney for his endeavour to make this plant a success, and to congratulate him on the fact that the initial plant has been so far successful that the original scheme goes forward practically in its entirety. I do not want to encroach on Mr. Chaney's reply to the discussion; but it may not be out of place—seeing that I was somewhat involved in the original scheme—to give the reasons for deciding on this plant.

Birmingham is an ideal place for the sale of coke. I do not think there is a better place in the country for the purpose; but what is applicable to Birmingham it does not follow is likely to be applicable to many other towns. It is a fact that there are coming into Birmingham every year 40,000 or 50,000 tons of metallurgical coke; and it occurred to us that, if we are to reduce the price of gas, seeing that we cannot get much out of labour and we cannot get much out of coal, therefore we must make the best of our residuals. If oven coke will fetch in Birmingham 5s. more a ton than is the case with ordinary gas-works coke, such an opportunity ought not to be missed by the Birmingham Gas Department. This was the reason for the adoption of the scheme. The next thing was we had to be perfectly sure that we obtained the first requirement of a gas engineer—that is to say, fairly good gas and plenty of it. These conditions were satisfied, and the plant that was chosen was the Koppers oven, because we thought it was the simplest oven on the market at that time. There were one or two modifications made on our suggestion. One was narrowing the oven down to 18 inches, in order that the heat might get to the interior of the charge more readily.

I have no doubt that Mr. Chaney can reply to Mr. Morrison's question about the capital. I have not discussed the matter with Mr. Chaney; but I can assure Mr. Morrison that the capital charge of this installation compared very favourably indeed with horizontal retorts. There is no house required, for one thing. I have no doubt that Mr. Chaney would be prepared privately to show him figures proving that the capital cost was no higher than with horizontal retorts and stoking machinery—that is to say, without ammonia recovery. With ammonia recovery, the return from the sulphate is equal to the labour and fuel and the other charges connected with the heating-up of the retorts. So that, whatever may be the cost of future installations, it is absolutely a fact that at that time the capital charge was entirely satisfactory to the Birmingham Corporation. With regard to the paper itself, I do not wish to make any comments, because Mr. Chaney has placed the matter so ably before the meeting; but I would like to say, as to the life of the chambers, that I saw when we were inspecting these plants coke-ovens which had been at work for six or eight years, and which were in excellent condition at the time. The results of the plant have entirely come up to our expectations, because it is undoubtedly a fact that this coke does fetch considerably more money than the ordinary gas-works coke in Birmingham.

Mr. W. R. HERRING (London): I take it that Birmingham has made special provision for itself in so far as regards finding an additional market for some of the coke resulting from the manufacture of coal gas. Whether this is applicable to many localities, is another question; but if Birmingham can take ordinary gas coal coke off the market, it must necessarily be of some advantage to those in the neighbourhood. So far as the gas results are concerned, from the paper we see that they are equal to the modern system of carbonizing, so that the financial results of the Birmingham scheme

depend entirely upon the enhanced value that can be obtained for the coke resulting from the special process. In this respect, it seems to me to be quite possible that in the future some of us—particularly the large works—may have to adapt ourselves to two or three types of plant, if we are not to flood the market with a product for which there is not very much demand, because we must remember that, on the one hand, we are endeavouring by every means in our power to supplant solid fuel in both domestic and industrial life. In doing this, we are producing a very much larger quantity of that solid fuel which, if thrown on a market not requiring it, will necessarily depreciate its value. So we may have to look seriously at some of these theories as to low-temperature carbonization. We are told by some that there is a market for a particular type of coke. We know by experience that there are some people who will pay a large price for oven coke because it is something superior to gas coke. Therefore, the time may come when we shall find it of some advantage to manufacture a special fuel, for after all I think the economy that lies in front of us, as gas engineers, is bound up with enhancing the solid products arising from gas manufacture.

There is just one point which has not been touched upon. I am not questioning the wisdom of feeding the retorts or the ovens by gas produced with generator firing; but the introduction of a separate installation of plant, requiring separate supervision in the working, and in which, above all things else, we are required to buy coal in order to produce fuel gas, is not economical. It is strange in a gas-works if we are to add to our coal purchases to produce the fuel gas. It is true that some economy may result from the recovery of the ammonia. I should like to ask Mr. Chaney what is his reason for departing from the common practice in coke-oven work, which is to take advantage of some of the gas produced in the ovens for the heating of them? He has already told us that the illuminating power is fully up to present-day requirements, and that so far as this is concerned it would be wasting it to use it direct. But coke-oven practice is to strip the gas by washing it, and returning only the fuel gas to the ovens. It seems to me that this would be a more economical way of dealing with the question of heating the ovens, and would also to a certain extent relieve the coke market.*

Mr. Ernst Körting: I have read with great interest this excellent paper on coke-oven carbonization. I have also inspected the plant at Vienna. No one can deny the skill of the producers of the plant; but all my experience as a gas engineer is against coke-ovens. I have seen dozens of gas-works put out of action by coke-ovens. I have gained my spurs in the retort-house; and I strongly object to the idea that carbonization should be given up. In the next place, the promoters of the coke-ovens do not confine themselves to the mining districts. They are going through the country like lions, trying to get people to put up coke-ovens as independent installations. There is always an inclination to do this on a very large scale; the inducement being the large demand for metallurgical coke in times of boom, and the big prices realized for tar, &c. The result is disastrous to the neighbouring gas-works, because metallurgical coke is the chief competitor of gas coke. I have heard many complaints from engineers with regard to coke-oven plants. While fully admitting the possibility of adopting coke-ovens in our gas-works for special purposes, in places like Birmingham, I altogether object to them for gas-works generally.

I have some figures comparing the production of gas from chambers and verticals with exactly the same coal, with the same chemists superintending the tests; and I have found that the vertical retorts produced 13 per cent. more gas than the coke-ovens. A big advantage of a high production of gas is a diminution in the production of coke. We have learnt during the last ten years in Berlin to make 20 per cent. more gas per ton of coal, with a corresponding decrease in the production of coke. Now the price of gas coke has risen very much more than the price of coal. It is nearly double as high as it was ten years ago. What I want to point out is that there is always a danger of losing sight of the old sound principle of our industry—that gas is the main object, and everything else is of secondary consideration. "*Timeo Danaos et dona ferentes.*"

Mr. Thomas Glover (Norwich): I have been interested in this question, as many of you know, for a number of years, and have experimented on a small scale in the making of coke which approximates to the samples that are before us this morning. As one who suffers from the competition of the coke brought in from the Midlands, I can only feel thankful that the Birmingham Corporation are taking measures to make a coke which will sell in their own neighbourhood, and prevent the dumping of their surplus coke into the Eastern Counties.

With regard to the quality of the coke, we found in working the "Norwich Chambers" that we could make foundry coke. But we suffered by reason of the fact that we could not always make the coke from one coal; and the iron founders, when they have got used to a certain quality of coke, like to stick to it. They like to have a coke which will take a certain weight, and will stand a certain blast, as well as having a certain standard of purity; and having secured this coke, they wish to stick to it. I mention this, because in considering this question gas companies, if they are going to make a certain quality of coke, will have to stick to a certain quality of coal, or else they will suffer in their market.

As to the alkalinity of coal, I have learnt that the coke-oven people suffer very considerably if care is not taken to purify the coal. In some cases, the firebrick material has suffered owing to the fact that the coal is not properly washed. Many of us who use washed coal have recently been finding that the coal is not washed in water, but in mud. I hope some of the coal people will hear this, because it has a very decided effect on the ash content of the coke we produce. In these days of pressure in the coal trade, they seem to be taking out of us all they can, and that is one of the ways in which they do it—namely, by not washing the coal in water. If the coal is to be free from alkali, it must be washed in clean water to begin with.

With regard to the question that has been raised as to the heating of retort benches or ovens with Mond gas, I think the system is one which should commend itself to us, provided that the capital charges are not too high. I some years ago approached the Mond people with reference to the cost of the plant, because I could buy slack at 10s. a ton and sell coke at 18s.; and if I could recover the price of the slack by the ammonia made, there would be certainly on the face of it, apart from capital charges, a very considerable gain. But the capital charges at that time prohibited the consideration of putting in an installation for a retort-house making 2½ million cubic feet. If this is so, the system is only applicable to very large concerns, and therefore has a limited application. I am personally sorry that it is so, because to me it is an ideal process, that we should recover the nitrogen that is in the fuel and get the benefit of it. We are ammonia makers; and if we can recover the ammonia in the fuel that we use in firing our benches, it seems to me only right that we should do so.

I think these, Sir, are the chief points that I have made a note of. Other speakers have said many of the things that I intended to say; but they have said them better than I could have done.

Dr. Rudolf Lessing (London): I should like to confine myself only to the last point mentioned by Mr. Glover, and that is the application of fuel gas to retort and coke-oven settings. This point was touched upon in your address, Sir, yesterday; and I think for various reasons it must commend itself to carbonizers. To anyone who has seen the enormous plant, I might call it, at Vienna, there is one point certainly that is very striking, quite apart from the coke-oven plant itself, and that is the fuel-gas plant. It is a gas-works quite in itself; and to anyone who sees what is necessary to do once you detach the producer-gas making from the setting itself, it must be a very striking thought to consider how little has been done in the past in this direction. If we come to consider that the gas made under the settings amounts to almost double the gas made per ton of coal carbonized, the amount of attention given to its production is certainly, even in the best-managed undertakings, a very inconsiderable one as compared with the amount of attention paid to the gas made inside the retort. The fact that gas undertakings to-day are in the forefront of smoke

* As will be seen by our "Review of the Proceedings," it is understood that ordinary coke can be used for the producers with a high ammonia yield—70 lbs. per ton. This appears to be a complete answer to Mr. Herring's point.

abaters should make them consider the possibility of applying cheap bituminous fuels in place of the coke which they produce, which is more valuable for fuel purposes. I cannot refrain from giving one definition of the converting of coal into coke and gas in the German language, because there is one word that German scientists use for this operation (with no English synonym), and that word is "Veredeln." This means "to improve," and it has a touch of ennobling in it. It means that you take a raw material and make another material of a higher rank out of it; and undoubtedly this is so with all the products made in a gas-works. In regard to this coke, we are all agreed that the value of it is a higher one; and the only economic question that remains to be settled is whether there will be a sufficient market for it to justify the gas manufacturer in making more of it. I think it is quite within the scope of gas undertakings to replace a good deal of the fuel which is used in the raw and unimproved state by coke and gas, even at the risk of having to provide larger plants, and giving them more attention. It is a question of very wide issue; but I think the subject of applying improved methods of distillation and carbonization to raw materials is one that will have to be considered. It must be to the interest of gas makers to take it in hand at once, lest some other competitors should do it.

Mr. H. D. Madden (Cardiff): It was not my intention to speak on this paper. I sent for the papers in advance, in accordance with the request of the Secretary, because I wanted to read them over carefully before coming to the meeting. I should like to take this opportunity of thanking Mr. Chaney for his contribution. I had the pleasure of seeing his plant at Saltley last week, when he was good enough to let me closely inspect it. There is one thing that has occurred to me with regard to the coke-oven question in gas-works practice. As Mr. Körting said, we are first gas makers; and while a large coke-oven installation may be good for a big gas-works, where the gas can be blended with gas from other plants, I was wondering whether it would be suitable for works of a smaller size, where the gas has to be put into the holder and sent to the town without admixture with other gas. I should like to know whether, in these 10-ton units, the density, the specific gravity, and the calorific value of the gas would not alter from time to time, and vary very considerably in between the charges of the ovens. I think as gas sellers, a regular supply is one of the most important points to be considered; and I shall be glad if Mr. Chaney could throw any light on it.

Mr. G. S. Sayner (Harrogate): There is only one matter that I should like to refer to. I was not here when the first part of the paper was read; but there seems to me to be a little inconsistency in it. When the author, referring to the fuel account, says that, assuming 12 per cent. of fuel is consumed per ton of coal carbonized in the ordinary method of heating retorts, it is questionable whether this figure may be reduced by outside producers, I suppose that he means to say "unless" working is carried on under ammonia recovery conditions.

The President: Before calling on the reader of the paper to reply, I have to tender an apology to Mr. Morrison. I had misunderstood the trend of his remarks. I thought that he was speaking about the general production of coke, and not the substitution of one particular kind of coke for his own.

Reply to the Discussion.

Mr. Chaney, in reply to the speakers, said: Judging from the discussion that has taken place, I take it that the use of coke-ovens in a gas-works is a debatable point. In answer to Mr. Morrison, as to capital outlay, I may say that the figure he mentions includes the whole of the capital expended on the Mond gas plant, the coke-quenching plant, and the ovens themselves. In other words, the whole of the plant comparable would be the retort-house, the retort-house benches, the various conveyors, elevators, and breakers, the railways alongside, the coke-screening plant—in fact, every charge up to loading the coke into waggons. If you isolate the capital, taking the Mond gas plant itself, you will find, reckoning on 20 per cent. for depreciation, repairs, maintenance, and interest—which is a fair figure, I think—that on this plant alone you are saving practically 7d. with the compressed coal, and 9d. with the uncompressed coal. So it really puts the capital as regards the Mond gas plant out of comparison, because you are already recovering on the plant 9d. a ton. Generally, the cost of the coke-ovens themselves is practically the same as the ordinary retort-bench, except that in the case of the Saltley installation we have laid ourselves out for making something more than furnace coke. It may not be necessary in Birmingham to put down machines for compressing the coal; but we installed these machines with the object later on of purchasing the best coal from the North of England, and making metallurgical coke, which, as you know, fetches a very high price anywhere. If you charge the ovens from the top, there is no reason why you should not make coke very similar to ordinary gas coke, except that it is somewhat larger. It is only a question of creating a demand for the improved material.

With regard to the cost of wages, Mr. Morrison mentions that at Sheffield their carbonizing charges are down to something like 6d. a ton. With regard to manufacturing charges, there is always a debate as to what is included and what is left out. But I take it this means the whole of the charges from the delivery of coal into the retort-house till the coke is removed from the retort-house. Compared with this figure, the oven coke would work out at 4·9d. on the stamped charge, and 4d. on the uncompressed charge. The other figures include various charges for plant, such as handling the coke, putting it in the waggons, screening it, and clearing up the breeze. Mr. Bell points out that the average price of furnace coke during the last five years has only been something like 5d. more than gas coke. I am not going to say that coke-ovens are applicable everywhere. The unit is somewhat large—8 tons is a lot to deal with. But the average price is not the colliery price of furnace coke; it is the actual price at which the coke is selling in the particular district. Though it may be 5d. a ton at the colliery, there are the railway rates to go on; and we should get the benefit of the railway rates, having paid for the delivery of the coal. Mr. Bell draws attention to the $15\frac{3}{4}$ per cent. of fuel. I point out in my paper that it is only with one producer, and consequently it is not a fair figure to put forward. I merely put it forward in the paper for what it is worth.

I do not think with outside producers you can reduce the fuel consumption of direct-fired regenerative furnaces. There is a sensible amount of heat lost which you cannot recover. But the economy lies in the fact that you can recover the money, which more than compensates for practically the whole cost of the fuel used. In reply to Mr. Herring, as to the reasons for the adoption of producer gas, instead of taking the surplus gas from the coke-ovens, in the ordinary way about 50 per cent. of the gas is wasted or used for power and other purposes, and the other 50 per cent. goes to heating the ovens. One strong feature was that we are out to make gas; we want all the gas, instead of heating the ovens with it. We have in most gas-works a bye-product in the shape of coke-dust, for which there is no market at present; and it was with the idea of utilizing this coke-dust and the small breeze that the outside producers were adopted. It was found by utilizing this dust the recovery was sufficient to cover the whole of the outlay that was entailed.

Mr. Glover has pointed out that there is only one market for this furnace coke. I think I have made it quite clear that, unless you like to disintegrate the coal, there is no reason why you should make furnace coke. By charging the coal on the top of the ovens, you get a very similar product to the ordinary gas coke. I think the capital outlay for the recovery of ammonia on a small plant would make it unremunerative. Then as to the suitability of the ovens for small gas-works, and as to the variation of quality, we worked these ovens for some considerable time entirely by themselves, and we found that the composition of the gas had been very consistent, and that the calorific value in particular had been very even. There is a slight difference in the gravity of oven gas, as compared with the gravity of coal gas; but this should not appreciably affect a town supply. As to Mr. Sayner's remarks with regard to the fuel, the figure given—$15\frac{3}{4}$ per cent.—is a high one; but my point is that with a regenerator using 12 per cent. of fuel, it is very doubtful if you could hope to get that lower. I thank you for the kind way you have been good enough to receive my paper.

LIQUID PURIFICATION.

By Dr. W. B. DAVIDSON, of Birmingham.

In presenting this paper, on the subject of purification of coal gas, the author wishes in the first place to make a general but comprehensive survey of all the ingredients present in the crude gas which may be called impurities, and to deal with the question of their removal from a commercial and practical point of view without entering at this time into too much detail. The term "liquid purification" is interpreted in its broadest sense; the impurities to be considered being tar, ammonia, naphthalene, hydrocyanic acid, sulphuretted hydrogen, carbon bisulphide, carbon dioxide and nitrogen. Carbon dioxide and nitrogen are not usually considered as impurities; but they are certainly not only useless adjuncts in that they are incombustible, but they also seriously reduce illuminating power and flame temperature, and are therefore better absent. Oxygen, the percentage content of which rarely amounts to as much as 1 per cent., may be left out of account.

1.—Tar.

This wonderfully complex product, containing as it does probably many hundreds of different compounds—nearly 200 of which have already been isolated and identified, varying in boiling point from blood heat to red heat—is a most important residual. With ordinary gas coals its value, at 3d. per gallon, may reach the sum of 3s. 6d., with cannel, 7s., per ton of coal carbonized. There are large differences in yield according to the retort system used; certain designs of vertical retorts producing as much as 5 gallons more than horizontal retorts with one ascension pipe worked at a high temperature. The nature of the tar also differs very much in these two cases.

What concerns us chiefly in fulfilling the object of the paper is the efficiency and cost of extraction. Here we must note that vertical retort installations have hitherto, so far as the writer has observed or can gather, not been designed successfully so as to reduce to a minimum the cost of tar handling in the retort-house as we have it in the old installations of horizontal and inclined retorts. The removal of the pitch from the hydraulic mains sometimes costs in labour as much as ½d. per ton of coal, and results in a slightly reduced price for the tar as a whole. As a result of observation and practical experience, the writer is of opinion that the working may be made just as easy as with the horizontal systems, by circulating hot tar in sufficient quantity through the hydraulic main, and providing agitators for mixing the contents of the same before running off. From the first, he made up his mind not to use the usual pitch-pans on the test installation of Dessau vertical retorts in Birmingham. By the use of a simple agitator, this purpose was accomplished.

Another difficulty usually experienced in working vertical retorts is stoppage of retort-house governors by carbon, dust, and pitch. This is particularly troublesome when the governor is placed too near the hydraulic main, or in such a position that the gas is not properly baffled previous to its entering the governor so as to allow of the deposition of dust mechanically carried. The older form of slotted valve has recently been departed from in the governors specially designed for vertical retorts; the reel or similar simple form, less liable to blockage, being substituted. This difficulty seems rather curious when it is remembered that vertical retorts produce tar containing only 3 or 4 per cent. by weight of free carbon, as compared with 20 to 30 per cent. in tar obtained from horizontals heated to the same high carbonizing temperature; and it will now be evident to most engineers having anything to do with the new vertical retort systems that the claim of "production of thin tar" must be taken with the proverbial grain of salt.

When the hydraulic main is very hot, as with coke-ovens and some vertical retorts, and contains little or no ammoniacal liquor, ammonium chloride shows itself in the form of small crystals, which render the tar less fluid and give rise to stoppages in the tar-pipes. A remedy for this is the introduction of water or liquor into the hydraulic main at definite intervals—preferably before agitating and drawing off the contents. The amount of ammonium chloride depends upon the percentage of sodium chloride (common salt) in the coal. This latter varies considerably with the district from which the coal is drawn. North Staffordshire and Yorkshire coals, for example, contain down to 0·04 per cent. by weight; while some Nottinghamshire and Derbyshire coals contain as much as 0·25 per cent. Salt content would appear to have some connection with the percentage of moisture, as the following table of Midland coals would indicate:—

Coal.	District.	Percentage by Weight.	
		Moisture.	Sodium Chloride.
No. 1	South Yorkshire	2·4	0·07
2	,,	4·2	0·15
3	North Staffordshire	2·0	0·04
4	,,	2·8	0·05
5	Nottinghamshire	5·7	0·10
6	,,	4·6	0·17
7	,,	6·0	0·25
8	Derbyshire	3·8	0·05
9	,,	2·0	0·06
10	,,	3·9	0·06
11	,,	5·3	0·07
12	,,	2·6	0·08
13	,,	8·3	0·24

The corrosive action of ammonium chloride, especially in the gaseous state, is very noticeable on the steel portions of the hydraulic main, and is a thing to be reckoned with. The author understands that efforts are being made in some coke-oven plants to collect the ammonium chloride solution from the hydraulic main, and to concentrate the same by working it round until it is strong enough to admit of profitably crystallizing out the salt. Market prices for chloride and sulphate of ammonia were listed respectively at 555s. and 288s. 9d. at the beginning of the present year; and if all the sodium chloride were converted into ammonium chloride, the total possible yield in the case of coal No. 7 would be 5·2 lbs. per ton of coal carbonized, equal to 15·5d. gross value. But it is questionable if the working up of this residual would as a general rule be remunerative.

Incidentally, attention may be called to the deleterious effect (that of a corrosive flux) of the sodium chloride on the internal walls of the retorts or ovens. Thus, any advantage that might be gained in recovering ammonium chloride separately would probably hardly make up for the increased cost of maintenance of carbonizing plant; so that by choice one would prefer, other things being equal, the coal with the lower salt content. Seeing that the presence of ammonium chloride in the tar is a great nuisance to the tar distiller, owing to its corrosive action on the stills, it is surely better that the gas maker should sell it in the liquor as far as possible, rather than in the tar.

For the most part tar is allowed to look after itself, and find its way to its subterranean storage according to the law of gravitation as best it may. On the other hand, the elaborate scheme originated by Feld a few years ago is probably not only of questionable commercial value but also practically unattainable as originally designed. Feld's idea was to utilize the heat already contained in the crude gas leaving the retorts, or the hydraulic main, to fractionate out the tar into (1) soft pitch, (2) heavy oils, (3) middle oils, retaining the lightest oils in the gas.

This separation was to be done with his new vertical centrifugal washer, which, it may be said, has introduced a new factor into gas washing and rendered it possible to achieve, in a way not previously dreamt of, the liquid purification of enormous quantities of gas at very much reduced cost. The author believes that the practical feasibility of the scheme has not yet been satisfactorily proved, nor are the commercial advantages of selling tar in different fractions certain. Hot tar washing has the effect of sending forward the naphthalene with the light oils, owing to its high vapour tension at temperatures above blood heat, and may therefore tend to accentuate the naphthalene nuisance, because the tar is not allowed to dissolve its usual quantity of that impurity.

There are two respects in which losses may be sustained by the gas manufacturer if he does not look carefully after tar removal. One is in the large amount of benzene which may be extracted by tar by too drastic condensation or

prolonged contact with the gas. A given works may produce tar containing only 2 per cent. by volume of benzene; another works carbonizing the same coal may sell a tar containing 5 per cent. of this valuable constituent—the gas thereby suffering to the extent of half-a-candle in illuminating power, or 4 B.Th.U. By extracting the tar quickly, by mechanical or other means, before the gas cools below, say, 100° to 120° Fahr., and by returning to the extractor the light tars separating out last, the gas will be able to retain the maximum amount of benzene, and the tar will contain the minimum. A second point is the degree of freedom of the gas from the last traces of tar before entering the ammonia washers. The presence of even a few grains of tar per 100 cubic feet is sufficient to render the ammonia washers inefficient or liable to get blocked up. This is more especially so when the removal of ammonia depends on the scrubbing action of wetted coke, wooden grids, or rotating bundles, brushes, &c., besides which repairs and renewals are formidable items of expenditure.

The amount of tar in the gas entering the first ammonia washer should not exceed 2 grains per 100 cubic feet of gas. If it is reduced below this, so much the better. Even the small amount of 4 grains of tar per 100 cubic feet proves very prejudicial to cyanogen extraction in the presence of ammonia. In carburetted water gas and Mond gas plants there is much left to be desired in this matter of tar purification. In the former case, the removal of sulphuretted hydrogen by the oxide is greatly interfered with; and in the latter there are various troubles brought about by tar, whether the gas be used for engines or for heating. Leaving out the cost of removing pitch from the hydraulic main, the special charges against tar purification beyond the condensers probably do not amount to more than 0·25d. per ton of coal carbonized, all charges included.

In this, and subsequent estimates, the writer bases his calculations on a plant dealing with gas made from 100,000 tons of coal per annum. Interest and depreciation will be taken at 10 per cent. per annum.

Cost of Tar Extraction.

Interest and depreciation, 10 per cent. on £800 . .	£80
Attendance and repairs, &c.	20
Total for 100,000 tons of coal per annum	£100

Cost per ton of coal = 0·25d.

Before leaving the question of tar removal, reference must be made to the ingenious but simple method employed on the coke-oven plant of the Otto-Hilgenstock Company, by which the tar is thoroughly washed out of the gas by high-pressure tar-sprays in a vertical conically constructed down pipe before the gas leaving the ovens has time or opportunity to fall in temperature below the dew point—that is, the temperature at which virgin liquor begins to form, usually 160° to 170° Fahr. The special object in view is the direct extraction by sulphuric acid of the ammonia in the gas, with production of crystallized ammonium sulphate free from tar.

Here the effect of hot tar washing is very noticeable in the large proportion of naphthalene carried forward in the gas to the condensers, where, however, by direct contact with cold water, cheap and efficient separation of the solid impurity can be effected. Whether or not this method can be safely applied to gas-works is doubtful.

It is said that minute traces of tar escape even the oxide boxes. If so, they must be exceedingly minute; otherwise the oil deposited in the gasholders and syphons would show contamination. The tar in Mond gas, on the other hand, is known to travel in the mains for many miles, even from a recovery plant where sawdust scrubbers are used.

The efficiency of the finishing tar-extractor, whether it be of the Pelouze and Audouin design or a Livesey washer, should exceed 90 per cent. Crude gas entering the hydraulic main usually contains about 8000 grains of tar per 100 cubic feet of gas. If it leaves the finishing extractor at 2 grains, the efficiency of purification up to that point is 99·98 per cent.

2.—Ammonia.

The value of this residual, when sold as liquor at present prices, sometimes reaches the figure of 3s. 4d. per ton of coal. With different coals and different methods of retorting, there are considerable variations in the yield. Between minimum and maximum for Midland gas coals (excluding cannel) we have about 10 gallons of 10 oz. liquor per ton of coal carbonized. A similar difference is observed between certain vertical retorts on the one hand and horizontal retorts with one ascension pipe on the other, the former giving a maximum and the latter a minimum.

Though ammonia is by far the most soluble of all known gases, it is by no means easy to wash-out the last traces of this compound. At least half of the ammonia is usually removed by the dew or aqueous fog that forms as the crude gas slowly cools in the hydraulic main, foul main, and condensers: the virgin liquor thus obtained containing practically all the fixed salts—that is, the salts not decomposed into ammonia and acid by mere boiling of the solution. The remaining 50 or 60 per cent. of the total ammonia must be removed either by water or by sulphuric acid; the former means being usually adopted on a gas-works. To do this effectually necessitates the use of at least two washers—a primary rough washer to remove the bulk of the remaining ammonia and at the same time, it may be, the last traces of tar (a Livesey washer for example), and a final washer presenting a large washing surface and providing very intimate contact of gas and water. The latter is preferably built-up of several sections to provide a number of stages in the washing process.

The smaller the quantity of ammonia left in the gas, the more difficult it is to wash out. Thus, though a final washer may, and ought to, have an efficiency of extraction of about 99 per cent. under ordinary conditions, it will fall short of this figure if: (1) The concentration of ammonia in the gas entering the washer is very low—say, below 30 grains per 100 cubic feet, or (2) the water entering the last washing chamber is above 60° Fahr., or (3) too little wash water is used, in other words if the effluent liquor is too strong—say, above 10 oz. strength. With water at a temperature of 50° Fahr. or under, as it generally is, and the strength of the liquor effluent from 4 oz. to 6 oz., the ammonia passing the final washer should not exceed an average of 1 grain per 100 cubic feet. The author fears, however, that, owing to want of proper regulation of wash water, breakdowns, and tar troubles, the losses are often much greater.

Assuming that a coal yields 12,000 cubic feet of crude gas—that is, including sulphuretted hydrogen—and 32 gallons of 10 oz. liquor, the content of ammonia in the gas entering the hydraulic main is then 400 grains per 100 cubic feet (leaving steam and tar vapours out of account) and with a loss of only 2 grains per 100 cubic feet, the efficiency of ammonia recovery is 99·5 per cent. On one of the large works of the Birmingham Gas Department the losses as measured by weekly tests of the gas for the past four years were as follows:—

Year.	Coal Carbonized. Tons.	Losses in Final Washing. Gallons. 10 oz. Total.	Per Ton of Coal.	Percentage of Total Yield.
1909	113,100 ..	40,700 ..	0·36 ..	1·2
1910	119,500 ..	26,000 ..	0·22 ..	0·7
1911	121,200 ..	17,900 ..	0·15 ..	0·5
1912	139,800 ..	31,000 ..	0·22 ..	0·7

With regard to the last year, it must be explained that the starting of cyanogen extraction with iron mud gave rise to difficulties with the washers—mainly back-pressure, which necessitated the removal of some of the wooden bundles of the horizontal rotary washers, thereby reducing the washing surface. This is not put forward as ideal working; it can be much improved upon. On the other hand, it may be remarked that working to anything approaching the old limit of 4 grains of ammonia per 100 cubic feet in the gas supplied to the district—that is to say, after passing both the ammonia washers and the oxide or lime purifiers—deserves the strongest possible condemnation as being outrageously wasteful. An efficiency of 99·5 per cent. total extraction looks highly satisfactory. But it may not represent the real efficiency; for, unfortunately, ammonia is all too volatile, and much may be lost on the works if the precaution of carefully enclosing supply jets and overflows is not attended to and tanks and troughs are not carefully covered in. Where there is any free ammonia in the liquor, exposure to the air spells loss; the stronger the solution the higher the vapour tension and the greater the loss.

Another point to observe is that ammonia in the presence of sulphuretted hydrogen and carbonic acid is very corrosive towards iron and steel; and it must therefore be distributed as far as possible in cast-iron pipes. These, again, require careful testing from time to time, as ammonia is a most searching liquid for joints, which require frequent caulking. Personally, the writer prefers to have cast-iron

liquor pipes above ground, or in troughs, and covered with tarred canvas as some additional security. The practice of supplying ammoniacal liquor from open jets to the hydraulic main continuously, is a pernicious one, in view of the loss of ammonia entailed; but in many cases the use of liquor is unavoidable without altering the design of the plant, as water renders the sales liquor too weak for sale or profitable working up.

The removal of sulphuretted hydrogen and carbonic acid by ammonia will be dealt with later. As regards the cost of ordinary ammonia washing, it may be put down, interest and depreciation included, at 1¾d. per ton of coal, on a large plant; but much depends on the type of washer employed. The following are the round figures:—

Cost of Ammonia Removal (Washing Only).

100,000 Tons per Annum.

Interest and depreciation on washing plant, 10 per cent. on £3000	£300
Power for washers and pumps	240
Water for ammonia extraction	70
Attendance and repairs, &c.	120
Total	£730

Per ton of coal, 1¾d.

3.—Naphthalene.

This heavy hydrocarbon would have been a valuable ingredient as regards both candle power and calorific value were it not for its fatal habit of condensing out in the solid state in awkward situations, or were it more volatile at ordinary temperatures. As it is, it can only be regarded as an impurity, seeing that the amount that condenses out is probably equivalent to a candle power of less than 0·02; this being the value of 0·001 per cent. by volume—that is, 2 grains per 100 cubic feet, or ½ oz. per ton of coal.

We find it most prevalent in gas made in horizontal or inclined retorts at high temperature or with light charges; least so in vertical retort gas, particularly gas from intermittent verticals. It is, however, not so much the quantity of naphthalene present that determines the necessity of purification as the proportion of vapour of heavy oils which will condense out along with the naphthalene and keep it in solution. The amount present in the gas entering the holders will depend to a great extent on the degree of condensation and on contact with the tar, which always retains at least 95 per cent. by weight of the total naphthalene produced by distillation.

This impurity offers at this time of day comparatively little difficulty when suitable preventive measures are employed. These consist either (1) in extracting the greater portion of the naphthalene by washing the gas with heavy oil, or (2) introducing into the gas a sufficient quantity of the vapours of oils having a somewhat lower boiling point than that of naphthalene, or (3) a combination of the two methods. The first method requires effective washing and careful attention in renewal of the oil solvent, and usually results in a slight loss in the candle power and very slight reduction in calorific value. To be on the safe side, two washings should be given. The second gives a gain in candle power and calorific value, requires little attention other than the maintenance of a constant flow of solvent into the vaporizer, and is fairly certain in its action. One drawback that has been experienced with this method is the pernicious action of the solvent deposited by condensation on the paint of the gasholders. There is also occasional trouble with joints, meters, and fittings due to condensation of oil. With the third method, one still has the trouble and expense of getting rid of the spent solvene, though to a limited extent. In the writer's opinion, the second method is the cheapest, taking everything into consideration.

One item that is not always conceded is the improvement in the quality of the gas so treated. One cannot remove a hydrocarbon like naphthalene, or add others such as xylene to the gas, without altering the candle power and calorific value to some extent; and as the maintenance of a certain standard of quality is an essential condition in every well-regulated undertaking, credit must be given when oil is vaporized into the gas, whether it be benzol or solvene or any other volatile hydrocarbon or mixture of such. Not only is the quality improved by the addition of these vapours, but the volume is also increased. When coal gas is carburetted with benzol at the outlet of the station meter, for example, it is usual to add to the meter readings 42 cubic feet for every gallon vaporized.

The amount requiring to be vaporized depends on the nature of the gas; but as a rule 10 gallons per million cubic feet suffice. Naphthalene solvents of the kind required for this process ought to have the great bulk distilling over between 130° and 200° C.

Most suitable oils can be prepared from carburetted water-gas tar. The first runnings can be used successfully, though redistillation is necessary to provide precisely the oil required to meet the worst cases of naphthalene trouble. Undistilled carburetted water-gas tar is used, the writer believes, in a few places; but this product varies so much in composition that it cannot always be certain in its action, particularly on the candle power. One important essential is that the oil should have a high solvent power for naphthalene. In this respect, as also in enriching power, solvents prepared from coal tar or carburetted water-gas tar are much superior to those of a paraffin nature. The solvent power in the former two cases, however, largely depends on the content of naphthalene already in the oil. This may be quite a high figure, as it is extremely difficult in purifying the oil to completely eliminate the naphthalene either by distillation or refrigeration.

The solvent power ought to exceed 15 parts by weight of naphthalene in 100 parts by weight of oil at 60° Fahr. The enrichment figure has been found by the writer to average something like 10,000 cubic feet candles per gallon with paraffin oils, tested with No. 1 or No. 2 argand, and 14,000 with solvents obtained from gas-works tar products. These figures must, however, be reduced by probably 20 or 30 per cent. to allow for the condensation that takes place in the holders and mains. The bulk of the condensation products may be advantageously used over again. This is better than putting them into the tar wells.

The gallonage vaporized per million cubic feet of gas is so small that it is a very difficult task to determine the enrichment in practical working. The writer had occasion to make this determination, and was obliged to have as many as sixty tests—thirty at the inlet of the naphthalene washer and thirty at the outlet, before a reliable average figure could be obtained; the difference in illuminating power being about one-sixth of a candle. Assuming that a Livesey washer is used, the cost of the preventive process No. 2 is estimated as follows:

	Debit.	*Credit.*
Interest and depreciation—10 per cent. on £750	£75	
10,000 gallons of solvent at 9d. per gallon	375	
Labour, repairs, &c.	50	
	500	
Value of enrichment—100,000,000 cubic feet candles at ¾d. per 1000		£310
Net cost per 100,000 tons of coal	£190 = 0·46d. per ton.	

4.—Hydrocyanic Acid.

The content of this vapour in crude coal gas amounts as a rule to only 0·22 per cent. by volume, which, converted into crystals of prussiate of soda, $Na_4Fe(CN)_6\ 10H_2O$, is equivalent to 4½ lbs. per 10,000 cubic feet, or 5·4 lbs. per ton of coal yielding 12,000 cubic feet. To ascertain the amount, the test should be carried out after the condensers and before the washers, as the ammoniacal liquor in the first washer carries down considerable quanties as ammonium sulphocyanide. The highest yield is obtainable from horizontal retorts heated to high temperatures and possessing only one ascension pipe, the long travel of the gases along the red-hot upper portions of the retort resulting no doubt in the partial conversion of ammonia into prussic acid according to the equation: $NH_3 + C = HCN + H_2$.

The lowest yield that the writer has observed has been obtained from intermittent vertical retorts which are highest in ammonia. There is, as a matter of fact, not much difference in total fixed nitrogen in the gaseous products from horizontals and verticals; the latter having an advantage. The following are some figures actually obtained over a few days' test, the same coal being used in each case.

	Horizontals with Two Ascension Pipes. Lbs.	Horizontals with One Ascension Pipe. Lbs.	Dessau Verticals. Lbs.
Prussiate of soda per ton of coal	6·05	about 7½	2·85

The elimination of hydrocyanic acid from coal gas, is, of course, optional. In any case the great bulk of it will be removed by the iron oxide in the ordinary purifier with formation of prussian blue, but for the sake of improved purity and the prevention of corrosion and stoppages in the services, it is very desirable that it should be removed as completely as possible. Many cases of corroded and stopped

service pipes are to be attributed to the action of hydrocyanic acid on the iron in the presence of traces of ammonia; the insoluble compound, ferrous-ammonium-ferrocyanide $Fe(NH_4)_2$. $Fe(CN)_6$ being the result.

During past years, until just recently, there has been small incentive to extract cyanogen for sale, owing to the low price of prussiate of soda. Recently prices have shown an upward tendency; and it is possible on a large plant to make a net profit of about 1d. for every pound of prussiate of soda recovered per ton of coal. When horizontal retorts are employed, the income, with a 90 per cent. extraction, should reach 4d. to 4½d. per ton of coal carbonized; with intermittent verticals, 2d. It is possible to have 90 per cent. efficiency of extraction only by ensuring very thorough washing [two washers in series can be used with advantage]; and very complete purification from tar is necessary, because the cyanogen washing should take place as a primary operation after the tar extractor. Iron sludge retains tar tenaciously, and when the content amounts to 2 or 3 per cent. it cannot with advantage be used again in the washers. A prussiate plant is rather costly, even if one does not go to the length of turning out crystals of 99 per cent. purity; and for small works sulphocyanide production will be found more profitable.

If a high concentration of liquor—say, 1 lb. of prussiate of soda per gallon of liquor—is aimed at, the washing efficiency of a single washer will probably only be from 60 to 70 per cent. The following figures are based on the writer's experience of manufacturing sodium prussiate liquor of about 10 per cent. concentration, with the extraction of 2½ lbs. reckoned as $Na_4Fe(CN)_6.10H_2O$ per ton of coal carbonized. The process is, however, not worked to the best advantage at present; the chief hindrances being the design of the washers employed and the presence of considerable quantities of tar.

On 100,000 Tons of Coal Carbonized.

Income from prussiate sold	£1760
Expenses: Interest and depreciation, £320; iron mud, soda ash, labour, and repairs, £600—total	920
Net profit	£840
= 2d. per ton of coal.	

The warning must be given that, even when the price of prussiate is satisfactory, by working with too small a plant or inefficient washing appliances, instead of a profit there may result a heavy loss.

5.—Sulphuretted Hydrogen.

The writer believes that a great deal of laxity prevails generally in the estimation of this impurity. Concern as to the quantity present is lessened by the fact that purification with oxide of iron is a very simple and convenient process. Again, exact methods of determination are rather troublesome. A reliable estimate can be formed from the sales of spent oxide and the sulphur content of the same, but only after years of working. With proper precautions, the ordinary absorption method of gas analysis can be applied with success, especially for purposes of comparison. Midland coals yield on an average 1·4 per cent. of sulphuretted hydrogen in the crude gas, which is equivalent to 14 lbs. of sulphur per ton of coal.

The following is a record of the annual averages for the Birmingham Gas-Works over a period of years:—

	1908. Per Cent.	1909. Per Cent.	1910. Per Cent.	1911. Per Cent.
1.—Horizontal retorts	1·36	1·27	1·52	1·37
2.—Horizontal and inclined retorts	1·53	1·14	1·19	1·10
3.—Inclined retorts	1·48	1·36	1·33	1·30
4.—Horizontal retorts	2·08	2·62	1·94	2·13*
5.— ,, ,,	2·10	1·88	1·92	1·87*
Straight average	1·71	1·65	1·58	1·55
True average (proportioned to make)	1·56	1·57	1·44	1·37

* Horizontal retorts with one ascension-pipe.

It is still more variable in water gas, as the following tests show:—

Works.	1908. Per Cent.	1909. Per Cent.	1910. Per Cent.	1911. Per Cent.
1.	2·04	1·59	1·55	1·60
2.	0·97	0·81	0·84	0·55
3.	1·11	1·12	1·61	1·58
Average	1·37	1·17	1·33	1·24

Between horizontal retorts with two ascension pipes on the one hand, and vertical retorts on the other, there would seem to be no very marked difference in the amount of H_2S produced. Definite data are not yet forthcoming.

There are no very striking differences except in the case of horizontal retorts heated to high temperature and fitted with one ascension pipe, which are much higher in this impurity. Coals, however, differ in a marked degree from one another in the amount of sulphuretted hydrogen evolved, as might be expected. The following list gives a comparison of a number of representative Midland gas coals, tested on the Birmingham large coal-test plant:—

	Percentage by Volume in Crude Gas.
15 Coals from Derbyshire and Nottinghamshire	2·28 highest 1·42 lowest 1·82 average
10 ,, ,, Yorkshire	2·01 highest 0·96 lowest 1·50 average
5 ,, ,, Staffordshire	2·04 highest 1·53 lowest 1·76 average
Total 30	2·28 highest 0·96 lowest 1·70 average

In order to see what economic possibilities there are in any scheme of liquid purification, including the removal of sulphuretted hydrogen, it will be necessary to look into the costs of the method now in common use. The annexed rough balance-sheet is based on the following assumptions: (1) Cost of complete plant for 100,000 tons of coal per annum, £25,000; (2) cost of new oxide, 25s. per ton; (3) wages, repairs, and power, 1¾d. per ton of coal carbonized; (4) sale price of sulphur in spent oxide, 3½d. per unit (per cent.) per ton, equivalent to 29s. 2d.—say, 30s. per ton of sulphur.

	£		£
Income:—620 tons of sulphur at 30s.	—	..	930
Expenditure:—Interest and depreciation, 10 per cent. on £25,000	2500	..	—
New oxide, 620 tons at 25s.	775	..	—
Wages, repairs, and power	725	..	—
	4000	..	930

Net cost £3070, equivalent to 7·4d. per ton of coal.

6.—Carbon Bisulphide.

Since 1905 there has been no legal obligation to remove this impurity from coal gas. The exclusive use of oxide reduces purification costs very considerably; but there is no elimination in the slightest degree of sulphur compounds other than sulphuretted hydrogen. Some large works carry out all sulphuretted hydrogen purification with lime, in which case there is always a quantity of carbon bisulphide removed, even though all the carbon dioxide be not previously eliminated. Where, again, lime is used only for the partial removal of carbonic acid some reduction in the amount of carbon bisulphide is effected, preventing the impurity reaching abnormal figures. It is purely a matter of opinion how far town gas should be freed from sulphur compounds. The fact should, however, not be forgotten that the consumption of gas per head of the population has gone up by leaps and bounds in the last decade, more particularly in industrial centres.

Assuming a sulphur content of 30 grains per 100 cubic feet (0·025 per cent. by volume of CS_2), the gas consumed in Birmingham is calculated to produce over 500 tons of sulphuric acid per annum. It is no wonder that a new system of carbonization, whereby the amount of organic sulphur in the coal gas is materially reduced, is hailed with much satisfaction equally with a cheap and effective means of removing this troublesome impurity. Highest sulphur is to be found in the gas evolved from horizontal retorts at high temperature and with one ascension pipe—in fact, with certain coals it goes up to 100 grains per 100 cubic feet.

The nature of the coal has a very important influence on this impurity, as will be seen by the following list, which embodies results obtained on horizontal retorts heated to about 1950° Fahr., and fitted with two ascension pipes.

	Grains per 100 Cubic Feet.
15 Coals from Derbyshire and Nottinghamshire	84 highest 23 lowest 41 average
10 ,, ,, Yorkshire	56 highest 22 lowest 34 average
5 ,, ,, Staffordshire	75 highest 33 lowest 47 average
Total 30	84 highest 22 lowest 40 average

In the reduction of the sulphur compounds other than

sulphuretted hydrogen, vertical retorts come to our aid. The writer observes, however, that the reduction is rather uncertain; being much greater with some coals than with others.

A method has been suggested of extracting carbon bisulphide with sulphided lime sludge; but the writer is not aware that this has actually been carried out. He has tried it on a small scale, and found it to work satisfactorily after the bulk of the carbonic acid was removed. When carbonic acid and CS_2 are both removed by lime in purifier boxes, the combined costs are very heavy, the dissection of which, against the respective impurities, the writer has not attempted.

7.—Carbon Dioxide.

It will be shown that this substance affects the gas prejudicially, and may therefore be classed among the impurities. As is the case with other impurities, the amount produced per ton of coal varies with the system of carbonizing and the nature of the coal. The following table gives the results obtained on the Birmingham coal-test plant (horizontal retorts, two ascension pipes) with different coals:

	Percentage of CO_2 by Volume.
15 Coals from Derbyshire and Nottinghamshire	2·66 highest
	1·56 lowest
	2·17 average
10 ,, ,, Yorkshire	3·53 highest
	1·19 lowest
	1·83 average
5 ,, ,, Staffordshire	3·54 highest
	1·51 lowest
	1·97 average
Total 30	3·54 highest
	1·19 lowest
	2·02 average

The figures for the large Birmingham works over a period of years are given below:

Percentage, by Volume, of CO_2.

	1908.	1909.	1910.	1911.
(1) Horizontal retorts	2·24	2·36	2·16	2·17
(2) Horizontal and inclined retorts	1·57	1·82	1·94	1·96
(3) Inclined retorts	1·98	2·00	2·31	2·61
(4) Horizontal retorts	2·49	1·86	2·02	2·64*
(5) Horizontal retorts	2·09	1·91	1·91	2·52*
Straight average	2·07	1·99	2·07	2·38
True average (proportional to make)	1·97	2·03	2·08	2·26

* One ascension pipe.

The addition of moisture produces an increase in the percentage of carbonic acid. The following example shows the effect:—

	Percentage of CO_2 by Volume.
Ordinary coal	2·20
,, ,, + 12½ per cent. of water added	3·55

There is little difference between horizontals with two ascension pipes and the various systems of vertical retorts with respect to carbonic acid content; but the increase in the case of horizontals with one ascension pipe is very marked. Comparative figures are given below:

Percentage, by Volume, of CO_2.

Horizontal Retorts, Two Ascension Pipes.	Horizontal Retorts, One Ascension Pipe.	De-sau Vertical Retorts.
2·20	about 3·0	2·45

The most drastic alteration, however, is caused by maintaining a strong exhaust of one or more tenths of an inch water gauge on the retorts. This results in drawing in waste gases from the furnace containing 20 per cent. of carbon dioxide and 80 per cent. of nitrogen, and also air through the lids or mouthpieces, the oxygen of which for the most part burns to carbonic acid. The following tests illustrate this effect:—

Coal.	Test.	Average Pressure in Retorts.	Percentage of CO_2 by Volume in Gas.
A	1	level gauge	2·22
	2	− 0·05 in.	2·67
B	1	level gauge	2·03
	2	− 0·05 in.	2·45
C	1	level gauge	2·13
	2	− 0·20 in.	3·02

One per cent. of carbonic acid added to an average sample of coal gas will reduce the illuminating power 3½ per cent., the yield will be increased by 1 per cent., and therefore the loss in cubic-feet-candles will be approximately 2½ per cent. To correct the multiple for carbonic acid content precisely on the above assumption, one would have to make use of the following correction table:—

When the percentage of CO_2 is:	the corresponding correction factor is
1·0	2·63
1·5	2·70
2·0	2·77
2·5	2·84
3·0	2·92
3·5	3·00
4·0	3·09

Method.—Multiply the percentage of carbonic acid in the gas by the corresponding factor. The product is the percentage to be added to the actual multiple.

It should be noted that the above figures have been determined with the Nos. 1 and 2 argand test-burners. With flat flame the corrections are considerably higher. The author has found the correction figure to be rather more than 3½ for gas produced by Dessau vertical retorts. It is hardly necessary to point out that the mere addition of carbonic acid brings about a *pro ratâ* reduction of the calorific value, while the total number of heat units in the gas produced from a ton of coal remains precisely the same—that is to say, although the total sperm value is materially reduced, the total heating value is not altered. The value and desirability of purifying the gas from carbonic acid will therefore depend on two main conditions: (1) Whether a high or moderately high candle power standard has to be worked to or not; (2) whether the calorific value of the gas normally obtained from the retort plant is sufficiently high to meet the demands of consumers. A third factor has also to be considered—namely, the prejudicial effect upon flame temperature and incandescent lighting.

Candle Power.—Until the day arrives when the flat flame may be considered practically a thing of the past, we need not be surprised if the consumer strongly objects, when the candle power as measured by his flat flame is reduced 50 per cent., as it is when it is lowered from 19 candles to 14 candles as tested with the No. 2 argand burner; the fall in illuminating power being much more rapid with flat-flame burners than with the modern test burner. There does not appear to the writer to be justifiable ground for assuming that town's gas need have no luminosity except with the incandescent burner, so long as practically every householder who is a gas consumer thinks he must have one or more flat-flames in his house.

Again, it is a fact, and one to be deplored, that some of the finest modern systems of carbonizing, while working under normal conditions of "pull" (producing gas with low nitrogen content) and only moderately high retort temperature, produce from average coals a gas which is scarcely high enough in calorific value to meet modern industrial requirements—a minimum of (say) 500 B.Th.U. at sea level, equal to 505 B.Th.U. in Birmingham.

The author has in a previous paper adduced the results of large-scale tests to indicate the results of "overpulling." In every case the illuminating power multiple (sperm value) was appreciably reduced, while the calorific value multiple was, on the other hand, distinctly increased; the latter effect being no doubt due mainly to the decrease in gas lost through leaks in the retorts. The following results illustrate the effects mentioned:—

Coal.	Test.	Pressure in Retorts.	Make. Cub. Ft.	I.P. No. 1.	I.P. Mult.	Diff. P. Ct.	C.V. Net.	C.V. Mult.	Diff. P. Ct.	CO_2. P. Ct.
No. 1	A.	level gauge	11,130	16·35	182		550	6120		2·13
,, ,,	B.	− 0·2 in.	12,400	13·75	171	−6·0	500	6210	+1·5	3·02
,, 2	C.	level gauge	12,290	15·31	188		529	6500		2·22
,, ,,	D.	− 0·05 in.	12,940	14·10	182	−3·2	505	6540	+0·6	2·67
,, 3	E.	level gauge	12,010	15·12	182		525	6305		2·19
,, ,,	F.	− 0·1 in.	12,680	13·58	172	−5·5	502	6370	+1·1	2·68

The purification of the gas from carbonic acid would in the above instances (tests B and D) increase the illuminating power by more than one candle, and the calorific value by some twelve or fifteen units—bringing the gas up to standard quality, and permitting full advantage to be taken of increased make per ton and improved calorific value multiple obtainable by additional exhaust.

Flame temperature, and consequently incandescent lighting, and general furnace work are improved by the removal of carbonic acid. If carbonic acid be added to a sample of gas, the efficiency of illumination per cubic foot of gas will be reduced by a much larger amount than the percentage added. The author has made the following tests, which throw some light on this subject. The results similarly obtained with nitrogen are given for the sake of comparison.

I.—*Flame Temperatures taken with Platinum-Platinum Rhodium Thermocouple in Centre of Méker Burner Coal-Gas Flame at a Definite Point near the Base.*

	Carbon Dioxide.	Reduction.
(1) Coal gas only	1210° C.	
,, ,, + 5 per cent. CO_2	1180° ,,	.. 30°
,, ,, + 10 ,, CO_2	1155° ,,	.. 25°
	Nitrogen.	Reduction.
(2) Coal gas only	1280° C.	
,, ,, + 5 per cent. N .	1255° ,,	.. 25°
,, ,, + 10 ,, N .	1235° ,,	.. 20°

II.—*Maximum Temperature.*

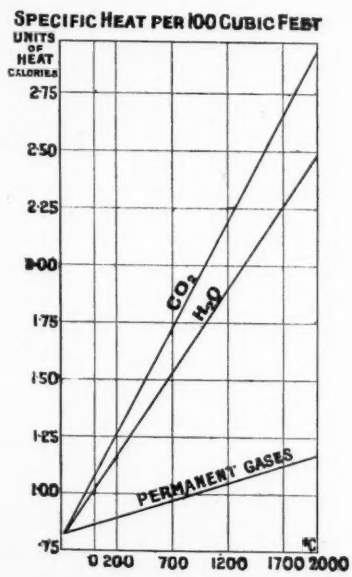
	Carbon Dioxide.	Reduction.
(1) Coal gas only	1320° C.	
,, ,, + 5 per cent. CO_2	1300° ,,	.. 20°
,, ,, + 10 ,, CO_2	1280° ,,	.. 20°
	Nitrogen.	Reduction.
(2) Coal gas only	1300° C.	
,, ,, + 5 per cent. N .	1285° ,,	.. 15°
,, ,, + 10 ,, N .	1270° ,,	.. 15°

It was difficult to obtain a very accurate reading of temperature; but the difference between the effect of carbonic acid and that of nitrogen was very distinct. The figures are rather low, and are to be taken as only relative.

III.—*The Effect on Incandescent Lighting was Compared on a Welsbach "C" Burner; the Maximum Efficiency being obtained in each case.*

	Candle Power at a Consumption of 5 Cubic Feet per Hour, Corrected.	Reduction per Cent.
1) Coal gas only	103·8	
,, ,, + 5 per cent. CO_2	93·7	.. 9·7
,, ,, + 10 ,, CO_2	85·4	.. 17·7
(2) Coal gas only	96·5	
,, ,, + 5 per cent. N .	90·2	.. 6·5
,, ,, + 10 ,, N .	84·4	.. 12·5

These results are to be anticipated when the specific heats of the products of combustion are compared. These increase rapidly with the temperature; the specific heat of carbon dioxide being higher than that of steam, and very much higher than that of nitrogen, as is shown by the accompanying diagram.



The conclusion is that when illuminating power is a matter of importance the elimination of carbonic acid is worth a great deal, because it can displace costly enriching agents, such as benzol and carburetted water gas—benzol entirely, and carburetted water gas all but the minimum required for taking up the peak loads.

If the standard of illuminating power is very low, and the calorific value standard well within reach with the poorest coals and the least efficient gas-making plant, the only advantage to be gained by eliminating carbonic acid is in flame temperature, incandescent lighting, and industrial heating; and it is a question if this gain compensates for the cost of purification. A very important point to remember, however, is that the removal of carbonic acid greatly facilitates the elimination of CS_2. Theoretically, it requires 100 times as much lime (CaO) to remove 2·5 per cent. by volume of carbonic acid as it does 0·025 per cent. (30 grains of sulphur per 100 cubic feet) of CS_2; so that it is a much better commercial proposition to remove the two impurities rather than only one of them.

8.—Nitrogen.

There is little to be said about this ingredient. The amount present in coal gas varies from 2 to 20 per cent. by volume; but the pure distillation of coal produces as a general rule only 1 per cent.—the surplus coming directly or indirectly from the atmosphere. It is much less harmful to candle power than carbonic acid; the reduction for 1 per cent. addition being 2·6 per cent., as against 3½. Like carbonic acid it is merely a diluent so far as heating value is concerned—that is to say, the quality of gas measured in heat units per cubic foot is reduced just in proportion to the percentage added. Having a low specific heat compared with carbonic acid or H_2O, its effect on flame temperature and incandescent lighting is not very deleterious. Drawn into the retorts from the furnace gases and the air it is, as previously stated, accompanied by carbonic acid. The increase in nitrogen content and reduction in the quality of the gas caused by overpulling is compensated to some extent, as in the case of carbonic acid, by a gain in total heat units in the gas made per ton of coal. Once admixed with coal gas no agent, liquid or solid, can effect its elimination.

Ammonia as a Purifying Agent.

The idea of making use of the alkaline properties of ammonia to purify gas from acid impurities, sulphuretted hydrogen and carbonic acid, has occupied the minds of gas engineers for several decades. To members of the Birmingham Gas Engineering Staff it became clear some years ago that Young, Hills, Claus, Holgate, and others in the sixties and subsequent years had not discovered the true science and art of distilling gas liquor. As every one knows, the large-scale experiments on the Claus process carried out at Belfast failed very badly. Not only was the elimination of sulphuretted hydrogen and carbonic acid very incomplete (about 50 per cent.), but the losses of ammonia were so great as to be fatal to any process of the kind. Moreover, the plant was very complicated, both as regards gas washing and treatment of the liquor. It was costly to erect, difficult to supervise, and almost constantly in need of repair. The task was rendered more difficult by the attempt to completely remove sulphur compounds other than sulphuretted hydrogen by the use of polysulphides.

In this connection, it may be remarked that the installation of the British cyanides process for the extraction of hydrocyanic acid with ammonium polysulphide in many gasworks some ten years ago proved of very little assistance, contrary to anticipation, in removing the sulphur compounds, though highly successful in removing cyanogen. At one of the Birmingham works, where the process was employed for seven or eight years, the sulphur eliminated was, on an average, not more than three or four grains per 100 cubic feet—a reduction of only 10 per cent.

During the past few years, the author has carried out a large number of experiments both in distilling and in gas washing on the works and in the laboratory, with results sufficiently promising to convince the Birmingham Gas Committee that something could be done on similar lines to those of the Claus process, but with important improvements in the methods of distilling the liquor and washing the gas.

About two years ago, the erection of a liquid purification plant was started on the coal-test plant for the treatment of the gas made by the test installation of eighteen Dessau retorts carbonizing 14 to 16 tons of coal per diem. The plant included a still, condensers, sulphur kiln, and depositing chambers, with the necessary tanks for storing liquor. With the object of carrying out preliminary tests an additional gas-washer of the vertical centrifugal type, together with a simple tower scrubber, had been provided a year previously. It is a pleasure to state that after a twelve months' trial—not quite continuous, as alterations were inevitable and coal tests had to be carried out—the process of extracting sulphuretted hydrogen and carbonic acid from the gas by means of purified ammonia solution has been pronounced successful, and the plant is now being enlarged and improved so as to deal with twice the amount of gas.

To go thoroughly into the whole question of ammonia

distillation and washing from the theoretical and practical points of view would lead too far at the present time; and it is intended to make it the subject of a future paper.

As regards distillation, suffice it to say that the chief improvement the author has introduced is the employment of a carefully regulated gradation of pressures in the still in addition to the control of temperature. It is a wonder that previous experimenters had not hit upon this very obvious aid to the separation of the three gases, NH_3, H_2S, and CO_2; pressure having a most important influence on the solution of all gases. The result is a great advance in the purity of the distillate, and a large diminution in the quantity of purified ammonia required for the washing operations. The distillation can be kept under perfect control, and is absolutely continuous, barring accident or blockages.

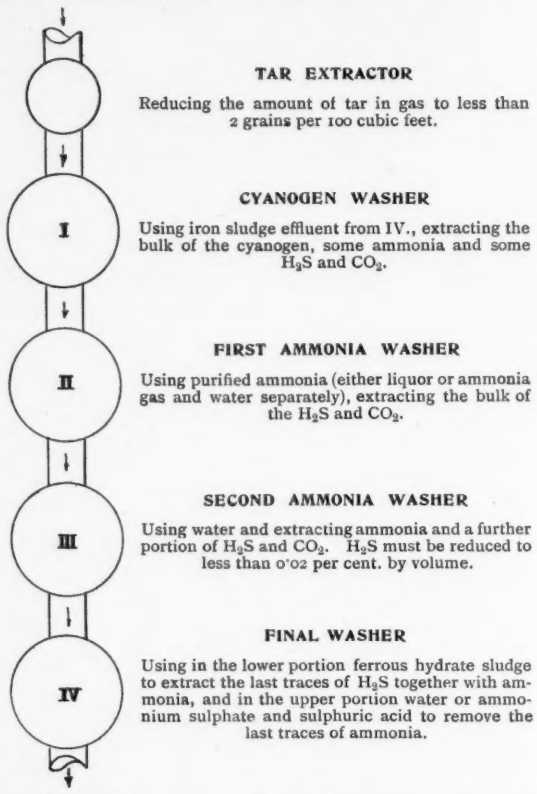
Another great advance that has been made since the days of the Windsor Street (Birmingham) and Belfast trials is in the art of gas washing. In particular, the advent of the vertical centrifugal spray washer makes the task very much easier. For large sizes, it can be erected at one-third the price of the older types of washers or scrubbers. It throws, or can be designed to throw, little or no back-pressure; making it possible to work a number in series without inconvenience. Further, it requires little driving power, can be made in very large sizes, costs little for cleaning or repairs, and can deal with heavy sludges. It was feared at first that the spraying action would have the effect of reducing the absorption effect; but this has not been found to be the case—it is, in fact, more suitable in this respect than the slow contact type of washer.

The small area required for such a washing plant as compared with purifier boxes is a great inducement in itself to instal a process of this kind, as many works could quite easily extend their carbonizing plant by the use of modern retort-settings, but have no ground area to spare for the additional purification that would be necessary.

Whether one wishes it or not, carbon dioxide must be removed in any ammonia process, not necessarily completely. Even if improvement of the quality of the gas is not desired, there is as already stated a great advantage in this in view of the facility afforded for the subsequent elimination of carbon bisulphide.

It is not intended to remove as a regular thing every trace of sulphuretted hydrogen by means of ammonia, though this can be done at the expense of an extra quantity of this purifying agent. At least 96 to 98 per cent. of the sulphuretted hydrogen is removed, and the final traces are to be taken out with ferrous hydrate sludge, which is an exceedingly active absorbent; the effluent sludge going to the primary cyanogen washer.

The following diagram will give a good idea of the washing plant necessary on a large works.


TAR EXTRACTOR
Reducing the amount of tar in gas to less than 2 grains per 100 cubic feet.
I
CYANOGEN WASHER
Using iron sludge effluent from IV., extracting the bulk of the cyanogen, some ammonia and some H_2S and CO_2.
II
FIRST AMMONIA WASHER
Using purified ammonia (either liquor or ammonia gas and water separately), extracting the bulk of the H_2S and CO_2.
III
SECOND AMMONIA WASHER
Using water and extracting ammonia and a further portion of H_2S and CO_2. H_2S must be reduced to less than 0·02 per cent. by volume.
IV
FINAL WASHER
Using in the lower portion ferrous hydrate sludge to extract the last traces of H_2S together with ammonia, and in the upper portion water or ammonium sulphate and sulphuric acid to remove the last traces of ammonia.

Provided with a cheap and effective means of manufacturing pure ammonia, one can naturally have a free choice of the sales product, whether ammonia itself or any of its salts. The accompanying table has been compiled so as to show the values, calculated to combined nitrogen, of the various products—prussiate, cyanide, and nitrate of soda

Commercial Values of Ammonia and its Compounds, &c.

—	Name.	Formula.	Theoretical Percentage of Nitrogen.	Percentage Purity of Commercial Article.	Percentage of Nitrogen in Commercial Article.	Price per Ton.	Price per Ton of Nitrogen.
						£	£
(1)	Ammonia, anhydrous	NH_3	82·25	100	82·25	130·7	158·9
(2)	,, ·880	NH_3 & H_2O	29·45	35·8	29·45	26·50	90·0
(3)	,, ·920	,, ,,	17·89	21·75	17·89	15·25	85·2
(4)	,, gas liquor, 10 oz.	,, ,, &c.	1·742	2·118	1·742	(approx.) 0·8	45·9
(5)	Ammonium carbonate	$NH_4HCO_3NH_4CO_2NH_2$	26·75	99	26·48	35·00	132·2
(6)	,, chloride	NH_4Cl	—	—	—	—	—
	(*a*) Muriate grey	,,	26·19	99	25·93	27·75	107·0
	(*b*) Sal ammoniac 1st.	,,	26·19	100	26·19	44·00	168·0
(7)	Ammonium nitrate	NH_4NO_3	17·50	99	34·67	35·50	102·4
(8)	,, sulphate	$(NH_4)_2SO_4$	21·20	95	20·14	14·44	71·7
(9)	Sodium prussiate	$Na_4Fe(CN)_6.10H_2O$	17·37	99	17·20	38·50	223·8
(10)	,, cyanide	NaCN	28·59	96	27·45	83·63	304·7
(11)	,, nitrate	$NaNO_3$	16·48	95	15·66	11·75	75·0

being included for the sake of comparison. Range of market, cost of chemicals, labour, and plant have naturally to be carefully considered in making a choice.

The cost of complete liquid purification plant for a large works promises to work out at a comparatively low figure per ton of coal carbonized. A definite balance-sheet, however, cannot be made out without more experience as to losses of ammonia and sale price of sulphur, &c. The former is very difficult to determine accurately; but so far as can be estimated at present it will not be at all serious.

DISCUSSION.

The President: I will ask Mr. Allen to open the discussion.

Mr. Edward Allen (Liverpool): I am quite sure that we all desire to express our appreciation and our indebtedness to the Gas Department of Birmingham for the very exceptional advantages we have derived from their research work during recent years, and for the valuable contributions made by their able officials. It is not necessary to enumerate these; but both in gas manufacture and distribution very valuable trials and research work have been carried out, and the results given to the industry. Our thanks are due to the Chairman and Committee for the facilities and encouragement given to their officials, who have brought to bear on the various problems their highly-trained technical powers, and have without reserve given the results to the gas profession. The paper which Dr. Davidson has contributed is of great practical value, and is also fruitful in suggestions. On seeing the title, one naturally supposed that the paper dealt with a method of purification that would displace the ordinary oxide and lime purifiers by something less troublesome and costly, and yet more efficient. The author has at the end of the paper given an instalment of this important subject; and if it is a pleasure to him to be able to state "that after twelve months' trial the process of extracting H_2S and CO_2 from the gas by means of purified

ammonia solution has been pronounced successful," it is equally a pleasure to us to hear the good news; and we are delighted to learn that Dr. Davidson intends to make it the subject of a future paper. Will he please hurry up, as some of us are being faced with the need for extensions, and so would be glad to be relieved from the necessity of covering the limited area at our disposal with the extensive purifying plant required under prevailing conditions.

There are a few points in the paper on which I should like to offer some comments. In the first place, with regard to tar. It is a surprise to hear that the claim of production of thin tar made on behalf of vertical retorts must be taken with a grain of salt. We hope to receive an assurance from the champions of this system, or those systems, that the troubles have been overcome.

I quite agree with the remarks as to the result of hot-tar washing by Feld's washer. This was tried at the Eccles Street works, Liverpool; but while perfectly successful in removing the tar from crude gas, the condensers were soon blocked with a naphthalene deposit, and the process was discontinued. The washer is, however, usefully employed washing with liquor the gas at the outlet of the condensers, and thus materially assisting the scrubbers in the removal of ammonia and some tar and CO_2.

The need for the removal of tar from carburetted water gas before it enters the purifiers is admitted by everyone, and various methods have been adopted. At present, we in Liverpool use filter-boxes charged with crushed clinker graded into four sizes, by means of which the fine vesicles of tar oil are arrested as the gas passes upward. This removes quite a large percentage, which can be seen running from the syphon-pipe. Another device, which is supplementary to the filters, is that of placing a disc in the inlet to the purifiers, with a narrow space between it and the side of the pipe, $\frac{3}{8}$ inch or less, by means of which the gas is suddenly contracted at the entrance and expanded as it leaves the constricted passage. The effect is to separate the liquid particles out of the gas, and leave it almost entirely free. The credit for this is due to Mr. Carter, the Superintendent at the Garston works. It is stated that a special design of Pelouze and Audouin tar-extractors is quite efficient in dealing with carburetted water gas, and we propose to instal one at the Linacre works.

Then with regard to the naphthalene. When coal gas is mixed with carburetted water gas—say, 30 to 50 per cent.—there is no trouble with naphthalene; but at two of the Liverpool works where coal gas only is made, there has been trouble on the works, and also in the districts. The first method adopted to effect a cure was to bubble the gas through a carburetted water-gas tar distillate in a CO_2 washer, with but poor results. Then "Solvene" was used, with no better success. The vapour apparently condensed on the works, or at an early period on the district; but the naphthalene went forward and deposited in service-pipes and lamp-cocks in the usual wicked way. Then we tried a "Simplex" vaporizer, after receiving a very good testimony of it from Mr. Price, of Hampton Court; and we met with perfect success. The material used was Russian vaporizing oil, specific gravity ·824; the first fraction (10 per cent.) coming off at 270° to 238° Fahr., and the last from 534° Fahr., at a specific gravity of ·852. Our experience differs from that described by the author in regard to enrichment caused by vaporizing. It is no doubt correct to say that the illuminating power of the gas is greater at the outlet than at the inlet of the washer; but by the time the gas has travelled through the holder and governors, and (say) 1000 yards of main, the vapour has re-condensed and brought down with it some naphthalene (for which we are grateful), and also other light hydrocarbons, to such an extent that the illuminating power is considerably reduced. Our experience shows that, because of this, gas of 18 candles by the flat-flame test becomes 16 candles on the district.

In conclusion, I wish to refer to what is said in the paper with regard to hydrocyanic acid. The yield of prussiate of soda is much higher than in our experience. Instead of $7\frac{1}{2}$ lbs. per ton of coal, our figure for the average of pure prussiate for the last completed half year was 3·44 lbs. The gas treated was made in an installation of horizontal retorts with one ascension-pipe; and we dealt with 260 tons per day at full work. There was a bench of inclines, each dealing with 80 tons per day. At the present price of prussiate—say, $3\frac{1}{2}$d. per pound—there is no encouragement to instal recovery plant. The income of 4d. to $4\frac{1}{2}$d. per ton given by the author is about right; but I hope, in the interests of existing makers of prussiate in gas-works, that other undertakings will leave us alone, and not spoil the market by over-production, and that at all events we shall be able to keep the price at $3\frac{1}{2}$d.

Mr. C. Dru Drury (Sunderland): I think we are all agreed that the question of the elimination of impurities from gas is intimately bound up with the production of the impurities; and that it is just as important to regulate our manufacture of gas so as to produce as little of the impurities that we do not want, and as much of those as we do want, as to consider the purification of gas itself. In other words, I think it is a case of prevention being better than cure. A perusal of Dr. Davidson's paper makes it quite evident that there are two extremes in the results obtained by him—on the one hand, gas produced from horizontal retorts with a single ascension-pipe, and gas produced from vertical retorts. After three or more years' experience with the Dessau vertical retorts, I can fully confirm the results which Dr. Davidson has arrived at so far as North of England coal is concerned. I find this very pronounced indeed, so far as the production of naphthalene and carbon bisulphide is concerned. As regards the formation of naphthalene, the gas produced from horizontal retorts has to be first washed with a solvent oil to prevent this impurity from being deposited in the mains; while there is no trace of naphthalene deposit from the gas made in the vertical retorts. Similarly, the average amount of CS_2 in the gas from the verticals, with oxide purification only, does not exceed 20 grains per 100 cubic feet; while the gas from horizontals under the same conditions contains more than twice this amount. With regard to those impurities that we do require—namely, tar and ammonia—there is no doubt that there is a considerable increase in the results obtained from vertical retorts, amounting to from 10 to 15 per cent. I would ask also, with Mr. Allen, why the question of thin tar from vertical retorts should be taken *cum grano salis*. I certainly find it better in many respects. The free carbon is very much less; also the water content is reduced to $1\frac{1}{2}$ per cent. in the case of tar from vertical retorts, both of which should improve the quality of the tar. The question of the removal of pitch from hydraulic mains is really a very small matter. I find that the amount of pitch in the pans is not more than $1\frac{1}{2}$ per cent. of the tar produced; and the cost of removal is certainly nothing like $\frac{1}{2}$d. per ton of coal. I certainly do not understand the balance-sheet given under the heading of sulphuretted hydrogen, with regard to the cost of purification by oxide. There are 620 tons of oxide taken, and 620 tons of sulphur is recovered. Does this mean that the weight of spent oxide is double that of the new oxide? If not, it indicates, as far as I can make out, 100 per cent. of saturation, which seems unlikely. In our case, we generally buy it with 50 per cent. moisture, and we sell it as spent with about 10 per cent.

Dr. Rudolf Lessing (London): There are two points that I should like to mention briefly. One is I would like to ask Dr. Davidson, with regard to the scheme he is putting forward, whether he has considered a suggestion I made a few years ago, which, of course, may not fit entirely into his scheme, but which might be combined with it. This was to use, in the final washer, instead of ferrous-hydrate sludge, ferrous-sulphate; leaving enough ammonia in the gas to saturate the ferrous-sulphate, and make sludge from it. I think it could be arranged, especially as Dr. Davidson does not propose to take all the sulphuretted hydrogen out by means of the sludge, but to leave some in the gas, which, I presume, would have to be taken out in oxide boxes, and thus an equivalent amount of sulphate of ammonia can be made, with no expense for acid.

With regard to carbon bisulphide, I should like to take this opportunity of drawing attention to a new process which is at present on trial on the Continent. It is not a liquid process, but might be usefully considered along with the process Dr. Davidson has put forward. This is its removal by means of alkalinated cellulose. This substance is a stranger in gas-works, but it is easily obtainable. The sulphide cellulose, in combination with alkali, is capable of entering into combination with carbon bisulphide forming a xanthogenate; and by distributing it in purifier-boxes, very much in the fashion of iron oxide, the carbon bisulphide can be easily abstracted from the gas. It does not apply to the thiophene and other sulphur compounds; but since these only amount to 10 per cent. of the total sulphur, they may be dis-

regarded. I have some tests by me showing that, in gases varying from 30 to 60 grains per 100 cubic feet in sulphur, there was a reduction down to 8, or possibly 9, grains.

Mr. W. W. Townsend (Hereford): There are one or two matters in connection with Dr. Davidson's paper that I should like to refer to. The first is with regard to carbon bisulphide. Certain figures are given; but the author does not state at what part of the process the gas is tested. Then, again, I am rather interested in the naphthalene difficulty. I notice that Dr. Davidson seems to assume that, in order to get rid of naphthalene, or reduce the trouble, it is absolutely necessary to adopt one of the three processes that he mentions. With all deference, I venture to say that, at any rate in some cases, it is possible to reduce the naphthalene so that it should give no trouble, by making use of the natural solvent capacity of coal tar, without any extraneous process whatever. I notice that, in the paper, Dr. Davidson, in order to ascertain the maximum amount of benzene in the gas, advocates withdrawing the tar at a temperature of 100°. I venture to say that this is not always the correct thing to do, because you may retain a little more benzene in the gas, but you will certainly retain a good deal more naphthalene at the same time. I have often wondered whether sufficient attention is paid to the fact that, in the ordinary condensation plant, the tar is removed by certain stages. The tar condenses in series; and in the first part of the condensers a good part of the tar is removed while it is still hot, and has not the opportunity of absorbing so much naphthalene as it would if cooled thoroughly. This has been done in a number of instances—for example, at the South Metropolitan works; and I have adopted it in my own case, and have not had the least trouble with naphthalene, though I work with rather high heats.

The next point I want to refer to is with reference to what is ordinarily considered liquid purification, involving the removal of as much CO_2 and H_2S as possible by the ammonia in the gas. I had hoped that Dr. Davidson would have told us what is the best method of doing this, and what, in ordinary circumstances, is the highest efficiency that can be obtained, because I think this is a matter of interest to all of us. We cannot all introduce a new process such as Dr. Davidson suggests; but we can, at any rate, make the fullest use of the ammonia that we have in our gas. I should like him to say how he accounts for the tremendous differences that exist, in different works, between the amount of fixed ammonia—whether this is caused by the constituents in the coal, or whether it is affected by the process of purification. Another interesting point that I came across the other day, in connection with liquid purification, is the fact that ammoniacal liquor dissolves a considerable amount of naphthalene. I have often wondered about this, and it has been discovered that it has an appreciable effect.

With regard to the new process of liquid purification that Dr. Davidson has mentioned, the details given in the paper are somewhat meagre. I am sorry to see that he does not hold out any hopes, at present, of a liquid purification absorbing carbon bisulphide. He refers to a process by the use of sulphided lime sludge for the absorption of C_2S. I hope he will continue his experiments in this direction, because such a process as this would be very simple, and would be a great boon to all gas undertakings. There is one further point in connection with carbon bisulphide. The author states in one place: "Where lime is used only for the partial removal of carbonic acid, some reduction in the amount of carbon bisulphide is effected, preventing the impurity reaching abnormal figures." I cannot quite understand this remark, because the removal of carbonic acid by lime is often done in the last purifier; and, in that case, I cannot understand how any carbon bisulphide can be removed by the lime.

Mr. R. Wardell (Enfield): Dr. Davidson, in his most interesting paper, has referred to a matter upon which I should like to say a few words, and that is with regard to the power required to drive vertical washers. While Dr. Davidson states that power is required to drive these machines, he has not given us any idea as to what the amount is. In connection with this question, I may say that we started a washer a little time ago; and when the makers were asked what power was wanted to drive it, they stated that 2½ H.P. would be sufficient. But we were much surprised to find, when the machine was started up, that something like 10 H.P. was required to drive it. The makers were informed of this; and, in order to satisfy them, a test on the motor was carried out, and showed conclusively that the washer did require this energy to drive it. I may say the washer was quite free. When at rest, a man could take hold of the spur-wheel and with one hand, turn it round; and, moreover, when all the chambers were empty, only 1½ H.P. was necessary to run it at its proper speed of 150 revolutions per minute, as against 10 H.P. on a full load. The motor, by the way, was only a 7 H.P. one. Seeing that the machine was to run day and night, we deemed it advisable to take the load comfortably, without running any risk of a breakdown. However, the speed of the machine was reduced to 135 revolutions a minute, and then 9 H.P. was required; and so a large motor was put in, to deal with this load, to replace the one originally used. If, therefore, a 2 million washer, running at this reduced speed requires 9 H.P., and four machines are necessary for a complete system of liquid purification, as shown by Dr. Davidson, a total of 36 H.P. would be required; and as two of the machines—or, at all events, a great portion of two of the machines—would be working in sludge, a further 10 per cent. should be added to this, making a total of 39½ H.P. If you take the cost of electrical energy at ½d. per unit, which I think is a reasonable figure, the running cost to-day would amount to £1 14s. 8d., which is equivalent to 0·21d. per 1000 cubic feet of gas treated, or 2·5d. per ton of coal carbonized. This figure does not include repairs, incidental charges, &c., but simply the bare cost of energy, and is, I think, sufficiently high, at all events, to justify its careful consideration whenever a scheme of liquid purification in closed vessels of the centrifugal type is in contemplation. Probably Dr. Davidson can give us some figures which will be useful for the purpose of comparison.

Mr. R. W. Edwards (Aldershot): May I ask if there is any improvement in the specific gravity of the gas by this method of purification, compared with the ordinary?

Mr. H. Kendrick (Stretford): Mention has been made of the loss of ammonia from the tanks and overflow pipes in connection with the ammonia plant in a gas-works; and I notice that Dr. Davidson made no reference to a process of absorption of ammonia which has been brought out by the Simon-Carvès Company for the direct recovery of ammonia. I have seen several of these plants at work; and the amount of ammonia recovered as sulphate in the plants I have seen varies from 50 per cent. to 100 per cent. more than the average of gas-works. At the same time, the managers have assured me that the amount of benzol recovered by washing with heavy oils was 20 per cent. more than from the gas that had been treated by the ordinary method—showing that if these plants were introduced into a gas-works there is a great possibility that there would be no effect on the illuminating power of the gas. I do not know whether Dr. Davidson has considered this in connection with his purifying methods; but I think it would be interesting to know his opinion of this type of plant.

Reference has been made to naphthalene, and the trouble with the deposition of the naphthalene solvents after the gas has left the works. At the Stretford works, we adopt the second process mentioned by Dr. Davidson; but we put in the solvent at the outlet of the meters. We get a very considerable amount of deposition; but we have found it of late in the gasholders. We found, though we can get a very low naphthalene content in the gas on the works, yet, at every spell of warm weather that we have had during the last six months, we had trouble on the district. My assistant suspected the gasholder; but I quite scouted the idea. However, he proved to be correct; and we found that there was an increase of 200 grains per 100 cubic feet after the gas had passed the holder—due probably to the rise in the temperature of the gas under the influence of the sun's rays. We are now skimming off the deposited solvent on the water, by the simple process of filling the tank up until the liquid overflows into the outlet pipes. I do not know whether anyone else has had this experience.

Then, with regard to another item, Dr. Davidson said we must take with a grain of salt the statement that the tar would be thinner with verticals than with horizontals. There is something else I should like to mention, which I do not know whether he will say ought also to be taken

with a grain of salt. It is that by merely changing the carbonizing from 6 to 12 cwt. charges, we get tar which is very much thinner; and whereas we used to have pitched mains and stopped pipes, for the last six months we have not had either.

There is another point, which has been referred to by Mr. Allen, in the previous discussion, and is mentioned both by Mr. Chaney and Dr. Davidson in their papers, and that is the effect of alkali on the fire-brickwork of our retorts. A great many works in the Lancashire district are in the habit of making a variety of "Coalexld;" and this involves adding alkali to the coal during the process of carbonization. I had some little demand for it in my own district, and I have been in the habit of using one particular bench for this purpose. The retorts in connection with this one bench are in very much worse condition than those adjoining it, which were erected at the same time; and it was only on reading these two papers which we have before us that I at all suspected the effect of the alkali. I should like, if I might, to make the suggestion, now, that the Refractory Materials Committee would make a few experiments on this particular subject. It would certainly be of interest to a considerable number of gas engineers in the Lancashire district.

Reply to the Discussion.

Dr. DAVIDSON: Mr. Allen has told us to hurry up; but you must know, gentlemen, that with any new process one cannot be too cautious, and in Birmingham, as elsewhere, we are hard hit by the present price of coal. You may depend upon it that the Gas Committee will not launch out into any new scheme unless we can guarantee a profit; and that is one reason why the experiments must be prolonged. It takes generally a year or two to get right through; and we do not know yet how profitable the process will be. If you do not see a plant going up in Birmingham in the next two or three years, you may take it that it is a failure. For instance, now in my own works the purifying plant cost £70,000 all complete for a make of 10,000,000 cubic feet. Now, that is a very big item; and it is almost as much as a retort-house. Naturally, you cannot scrap it all at once. You cannot instal a new plant on a large scale without a thorough trial. If it is in a new works, then, of course, it is very much easier. Mr. Allen speaks about the enrichment due to solvent. I have gone into this question very thoroughly. It is quite true that at times you drop the illuminating power; but taking the average throughout the year, the amount of deposit from the oil vapour that is put into the gas is only a very small percentage of what is put in, and if the deposition is much less than what is put in naturally there must be an increase in illuminating power and calorific value, because the enriching value of the oils is practically just the same as benzol itself. The figure given by Mr. Allen for prussiate of soda per ton of coal, I consider is a very low one. The figure I quoted for horizontal retorts with a single ascension-pipe was on a splendid system—the best in Belgium, working at a temperature of 2000° Fahr., which is a very high temperature indeed. It is a beautifully heated setting. When the retorts are reduced to 1900° Fahr., the yield is considerably lessened.

Mr. Dru Drury says that the Dessau retort tar is thin. I do not say it is not thin; but I say that is not the whole truth. I say that the tar in vertical retorts is more difficult to deal with than the tar from horizontal or inclined retorts. We have proved this thoroughly at our test plant. We cannot deal with it the same as we can with tar from horizontal retorts. Despite the fact that it is a splendid tar, and contains very little free carbon, it is very difficult to mix and tends to separate out thick; the pumps fail to get hold of it, and we have had several difficulties of this kind. I consider that ½d. per ton of coal is a very big charge; and that has been paid with some verticals for the removal of pitch from the hydraulic mains day by day.

With regard to the oxide, what I had in my mind was an oxide containing a low percentage of moisture—say, about 10 per cent. To that the oxide doubles its weight, that is under the best conditions, getting 60 per cent. of sulphur in the spent oxide. The figures are, of course, only approximate. I thought there might be some criticism of the figure that I have given for depreciation. That is the thing that I feared most; but after reading Dr. Humphreys' valuable paper on this subject, I certainly modified my views a little. As you know, it is customary in gas-works to take the depreciation figure very high; and I think 10 per cent. would be nearer the truth.

Dr. Lessing suggests the use of ferrous sulphate. I had thought of it. I thought that it would be a good plan to try it; but there are certain objections to its use. It is a thing which suggests itself, because you get both the effect of the iron and the effect of the acid. We are obliged to him for the information he has given us about the alkalinated cellulose. Then Mr. Townsend makes some very valuable remarks. He first of all asks about the percentage of CO_2. This was taken on the purified gas. There certainly is a slight variation in the different works, according to the number of washers employed for removing the ammonia. If you have treble washing—that is to say, a Livesey washer followed by two ammonia washers in series—you remove a certain amount of CO_2. If you have only a double washer, there is less removed. The figures were given with regard to purified gas; and there is really not much difference. I did not mean to convey that I thought there were only three methods of dealing successfully with naphthalene. I suppose you could quote a score of methods; but I said that what were given were the three most successful. I am aware there is a slight doubt about removing the tar at 100° Fahr. I put the figure forward not so much from practical experience as more from theoretical considerations. In removing the tar, I should not do it by the ordinary method. I should do it by a special machine. Of course, I could not go fully into the method of distilling. I wish to leave that open to a later date. The differences in fixed ammonia are no doubt, as Mr. Townsend says, due mainly to impurities in the coal. At any rate, they may be from that. A liquid purification of CS_2, as he remarks, would be a very convenient thing; but one does not care to do things by halves, and would rather purify entirely by liquid. Mr. Townsend cannot understand why I said that CS_2 was removed along with CO_2. It is bound to be so. There are a great many acids in coal gas, CO_2 is the strongest, H_2S is the next, then CS_2; and acetylene has slightly acid properties. When the base lime acts on these impurities, the acids compete for the base according to their relative strengths. So that the CS_2 is bound to get a little of the lime, as well as the CO_2.

In regard to Mr. Wardell's criticism, I have the actual figures for the working of the Feld washer with 20 per cent. sludge—that is to say, 20 per cent. of dry matter. On an 8½ million plant, the power, if I remember the decimal place correctly, was 7·4 B.H.P. Now, if you consider the horse power required on an ordinary rotary horizontal washer for 8½ millions, I do not think anyone can say it is less than double that. This was working at a speed with a Feld washer of 120 revolutions. Another gentleman asked with regard to the specific gravity of the gas. Naturally it would be reduced, and this would be all the better for distribution. Mr. Kendrick refers to the Simon-Carvès method of extracting ammonia. Of course, any method in which acid is used is certainly very efficient; but if you can get 99½ per cent. efficiency of extraction with the water, and if you remember that it is doubtful whether acid can be safely employed without heavier expenses in repairs, &c., I do not think the acid method is worthy of much consideration, if you are using the ammonia method that I have referred to. The oil deposit in the gasholders we are all very familiar with in Birmingham, because it interferes with the paint. We have noticed that at certain times of the year the naphthalene is higher on the outlet of the gasholder than on the inlet. I do not think it affects stoppages on the district much, because the oils go forward at the same time. I have noticed the same deposit when no solvent at all is used, when making very rich carburetted water gas. It is never seen to a greater extent than when that happens; and this carries down the naphthalene as well.

In conclusion, gentlemen, I thank you for the kind hearing you have given me; and, as I omitted to do so in my paper, I also wish to express my thanks to the Birmingham Gas Committee for their kind permission in allowing me to put these facts before you.

The PRESIDENT: I think, gentlemen, we shall all join with Dr. Davidson in an expression of thanks to the Corporation of Birmingham for permitting these papers to be read before us. I should like here to take an opportunity of expressing the great regret I feel at the absence of the General Manager of the Gas Department, who writes to me that he is too unwell to be present. We now have twenty minutes

left for the reading and discussion of another paper; and what has taken place this morning has driven me to the conclusion that we try to get too much into these meetings, that the number of papers is too large, and either we must revert to our old custom of having an afternoon sitting as well as a morning one, or else we must reduce the number of papers. I think it is decidedly to the disadvantage of the Institution that the time which may be devoted to the discussion of papers that are so full of interest and importance as those we have listened to to-day should be limited.

NOTES ON "GASEOUS HEATING."

By E. W. SMITH and C. M. WALTER, of Birmingham.

In presenting this paper for the consideration of the members of the Institution, the authors wish it to be considered as a further contribution to the subject of "gaseous heating" rather than as in any sense a complete or final dissertation on even those comparatively few points with which they propose to deal.

The domestic side of gaseous heating, although perhaps the more important one—the potential and actual consumption from that source being high, and the margin of profit on the gas sold under this head being, in the majority of cases, greater than that sold as "industrial" gas—will be left untouched, although many of the theoretical and practical considerations that are raised here are equally applicable to the working of gas-fires.

Illuminating Power v. Calorific Value.

The illuminating power of town-gas is rapidly becoming of less and less importance, and the calorific value has assumed the premier position. With the rapidly-increasing use of incandescent lighting, even illumination no longer depends on the candle power of the naked flame. Perhaps a useful purpose will be served if we ask you to review, briefly, what quality of gas is best suited for use in heating processes. It will be agreed at the outset, that it is of much more importance that the quality of the gas should be fairly constant, whatever it is, than that it should be high. If the calorific value be high and very irregular, less satisfaction will be given to the consumer than if the calorific value be much lower but more constant. A satisfactory gas for a town gas is one averaging 520 B.Th.U. net, and not varying by more than 3 per cent., or 15 B.Th.U. either way.

With modern plant and proper supervision, where only coals of the same class are used, there should be little difficulty in attaining this standard—it being a much easier one to work to than the present illuminating power standard. But evenness in calorific value is not the only factor to be taken into account. Where water-gas is employed for enrichment purposes it is, naturally, only used when enrichment is necessary. Its high specific gravity and its high calorific value will have a tendency to make the town gas streaky—varying considerably in calorific value and also in specific gravity. This latter should not be allowed to vary too much, as the volume of gas passing through the jets of the apparatus in which the gas is being burnt will vary inversely as the square root of the specific gravity of the gas. With high-density gas, less gas will be burnt than with low-density gas, and consequently less heat be generated and temperatures will drop. The effect of increase in density is equivalent, in furnace working, to a drop in the calorific value of the gas.

For example, it is not an unheard-of thing in bad cases for a specific gravity to vary from ·45 to ·60 on town gas. This would mean that the amount of gas passing through a given jet, passing 100 cubic feet an hour at ·45, will decrease to 86·5 at ·6.

$$\frac{100}{1} \times \sqrt{\frac{\cdot 45}{\cdot 6}} = 86\cdot 5$$

Most frequently high specific gravity is accompanied by higher calorific value; a ·6 gas in all probability having a calorific value of 600 B.Th.U.—or an increase of 12 per cent.

Serious variations of quality—calorific value and density—will produce a further difficulty; the aëration of the mixtures in the burners will vary too. These are all controllable factors in heating efficiencies; but they none the less have to be borne in mind and carefully watched. We believe we are rapidly approaching the time when, though the sulphur clauses be removed, it will be necessary for all gas undertakings to completely abstract the sulphur compounds contained in the gas. This is as necessary for lighting gas as for heating gas. When the carbonic acid and sulphuretted hydrogen of coal gas are extracted with ammonia, very little difficulty will arise in removing the sulphur compounds by means of sulphided lime.

The quantity of gas used on a furnace will also vary with the barometric pressure and the temperature of the gas. It is possible to get extremes of 28 and 30 inches barometric pressure. In such a case, the number of B.Th.U. passing per hour would be 6·7 per cent. more at the higher pressure than the former.

A difference in temperature of 15° Fahr. is not exceptional. This would make a difference of 3 per cent. It must be remembered, however, that these variations never occur at once all in the same direction—they usually having a nullifying effect one on the other.

Constant Pressure Essential.

Constant pressures at the furnace jets are perhaps as important as unvarying quality. There is no need to labour this point—it being an almost universally accepted fact. The only difficulty that arises is as to the best means of maintaining constant pressures at the consumers' jets. Some prefer governors at each furnace, others one governor at the meter. In the latter case—especially in low-pressure installations—it is necessary that the supply pipes should be well above the capacity of the work they are called upon, or are likely to be called upon, to do.

Assuming that a correct gas is being supplied in an efficient way, What is the best way of burning the gas to give the best results and highest efficiencies? When gas of known composition is burnt completely, a certain quantity of heat is generated. However it may be burnt, the amount of heat so generated is invariable. It may be burnt so slowly that the products are not raised more than a few degrees, and it may be burnt at such a rate that the temperature of the flame reaches well over 2000° C. The total heat evolved is the same in either case.

For the purpose of this discussion of the subject, it may be said that the methods of heating may be divided into two classes.

1.—Direct heating from flames by means of such appliances as ring and bar burners.

2.—Indirect heating, as in the instances in which the gas is burnt in contact with refractory material, which is raised to a high temperature and radiates its heat on to the object it is primarily desired to raise in temperature. All muffle and oven furnaces are of this type.

The effects to be obtained in each of these processes can be varied almost to infinity. In the first method, more especially, heating efficiencies depend very largely on the temperatures attained in the flames. It has been well pointed out by Professor Dalby, in his paper on "Heat Transmission," how high initial temperatures affect heating results. As an illustration, he examines the heat changes that take place in the fire-box of a steam-boiler, and traces the drop in head of heat in its transmission from one medium to another. The combusting gases in the fire-box have a temperature of over 1000° C. These give up their heat to the film of non-circulating gas found on the surface of the boiler plate at an average thickness of $\frac{1}{40}$th of an inch. The heat has then to be transferred to the scale on the plate, through the scale, from the scale to the plate, through the plate, from the plate, through any scale or grease that may line the inside of the boiler, to the film of non-circulating water, and from this film to the main bulk of the water.

Each stage in the transmission reduces the initial head of heat—say, 1000° C.—until a temperature of about 100° C. is attained in the water. It is shown that well over 90 per cent. of this head of heat is lost in its transference through the thin gas film on the fire-box side of the boiler-plate. As

is to be expected, the better and more rapid the circulation of the gases in the fire-box the thinner will be this gas film and the less will be the drop in temperature head. The higher the initial temperature is, the higher will be the final temperature of the containing box and the quicker will be the flow of heat. This all has a very important bearing on the results to be obtained in gaseous heating by means of naked flames. It may safely be assumed that no more than 10 per cent. of the heat generated in the flames of industrial ring-burners is radiated, and little more than half this will be radiated in a useful direction. Consequently, the heating will have to depend very largely on the actual contact of the hot gases—completely combusted and partly combusted—with the vessel to be heated. Here we have similar conditions to those present in the experiments described by Professor Dalby.

Some time ago, we were asked what we should suggest as the most efficient apparatus in which to melt, and maintain at a given temperature, large bodies of white metal. Two important points had first to be settled. Firstly, what in this instance would be the best way of applying the gas to the pots; and, secondly, what shape of pot would give the best results. Let us take the second of these points first. When considering the melting of such metals, it will be evident that the fuel costs will to a great extent depend on the quantity which has to be dealt with at one time in relation to the shape of the pot. For example, if we compare a bowl-shaped pot, the internal diameter of which is (say) one unit, with another pot the internal diameter of which is (say) 2 units, then the capacity of the latter pot will be approximately eight times that of the former; while the heating surfaces of the two pots are approximately in the ratio of 1:4. This means that the heating surface of the larger pot per pound of metal contained in it is only half that in the case of the smaller pot. This explains why the cost of melting such metals in bowl-shaped or conical pots increases as the quantity to be dealt with increases. The converse, however, also holds good; and if we consider the cooling effect on the metal we have, neglecting the surface effects—the smaller pot losing heat at twice the rate of the larger pot—thus the cost of maintaining the metal in the molten state will be much less in the case of the larger pot than in the case of the former pot. It will thus be seen that the shape of the pot adopted will to a large extent effect both the melting and maintaining costs.

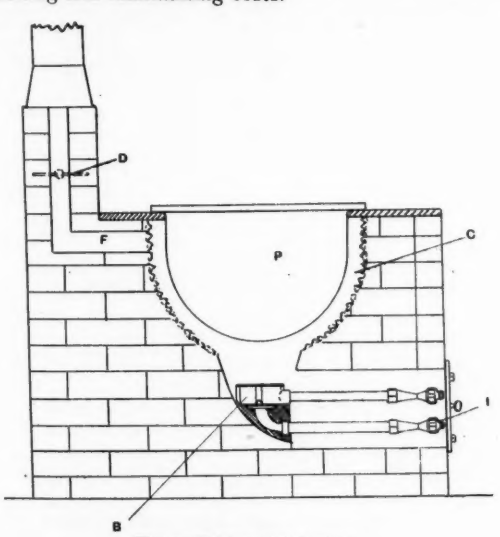


Fig. 1—Melting-Pot Setting.

Fig. 1 represents a section through a lead melting pot setting heated by means of a high-pressure gas chamber burner (fig. 2). It will be seen that the combustion space

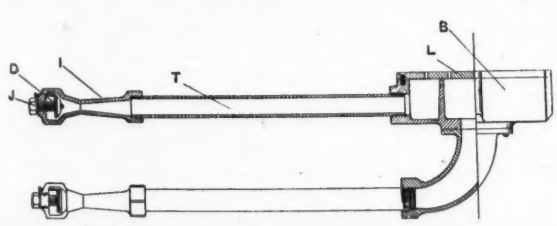


Fig. 2—Duplex High-Pressure Chamber-Burner.

C (fig. 1) is shaped to the pot P; the space between the pot itself and the furnace wall not exceeding 2½ inches in the case of the largest pots, having a capacity of upwards of 2 tons. The high-pressure duplex burner is fitted with injectors I (fig. 2); the burner chamber being closed by a door having an opening left in it for the admission of secondary air. The flue outlet F (fig. 1) is placed at the back as near to the rim of the pot as possible, and should take the shape of a horizontal slit having a height not exceeding 2 inches; the width being arranged according to the amount of gas burnt. The main flue should be fitted with a damper D.

The fire-brick wall of the setting should be rough cast with broken fire-brick and ganister, so as to expose to the flames as large a heating surface as possible. If conical pots are used, these should preferably be made of close-grained cast-iron—having a minimum thickness of ⅜ inch in the case of small pots, and 2 inches in the case of the larger pots. Wrought-iron pots of this type have been tried; but owing to their short life they have had to be abandoned.

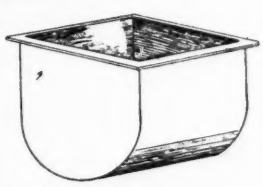


Fig. 3—Bath-Shaped Lead-Melting Pot.

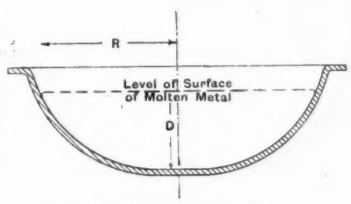


Fig. 4—Basin-Shaped Lead-Melting Pot.

Fig. 3 represents a bath-shaped pot composed of ½ inch wrought-iron plate with the ends welded in, which was designed with a view to obtaining greater heating surface as compared with that of a conical pot of the same capacity. A pot of this type having dimensions 27 in. by 27 in. by 24 in. deep was constructed for the melting of a solder composed of lead and tin in equal proportions. Two single burners were fitted, each having a consumption of about 225 cubic feet per hour; the gas being supplied at a pressure of 11½ lbs. per square inch. With the setting heated up, it was found that 35 cwt. of such metal could be reduced to a molten state and raised to a temperature of 650° Fahr. in 1 hour 35 minutes; the gas rate during this period being 450 cubic feet per hour, and the gas used having a net calorific value of 530 B.Th.U. per cubic foot. When in the molten state, the consumption of gas required to maintain the metal at a temperature of 600° Fahr. was 200 cubic feet per hour—this corresponding to a gas consumption of 20·3 cubic feet per cwt. for complete melting, and 5·7 cubic feet per cwt. per hour for maintaining at a temperature of 600° Fahr. These figures compare very favourably with those obtained in the case of conical pots.

Fig. 2 represents a section of the duplex burner used. B is the double chamber cast-iron head; L, the detachable lid; T, ¾-inch gas-piping cut to any required length; and I, the injectors fitted with the jets J and air-regulating cones D. These burners are also used for sugar boiling, varnish making, and for the boiling of liquids in vats.

Fig. 4 represents a section through the ordinary basin-shaped conical cast-iron lead melting pot. Owing to the shape of these pots departing considerably from the hemisphere, we have deduced the following formula for obtaining the approximate capacity, which is—

If R = radius of surface of molten metal in inches.
d = depth from centre of metal surface to centre of bottom of pot in inches.
Then W = capacity of pot in lbs. lead.
$$= \cdot 215\ (R^2 d + d^3)$$

Perhaps the more important point to be considered is the method of applying the gas to the pots to be heated. A number of important conditions have to be fulfilled if the highest efficiencies are to be attained. The temperature of the flames must be as high as possible. The flame shall be as close to the pot as possible, without retarding combustion. The film of gas always present on the outer surface of the pan shall be reduced to a minimum, in order that the temperature head shall not be lowered any more than is absolutely necessary. If it can be arranged, it is an advantage to introduce a mechanical stirrer into the molten metal. This serves the double purpose of interfering to some extent with the thin film of non-circulating metal in contact with the sides of the pot and also bringing the large bulk of the

metal into intimate contact with the hottest parts of the pan.

What do we know about the temperatures of flames? And how are the highest temperatures to be attained in flames formed by the combustion of coal gas and air? We know that the temperature of a flame depends on:

1.—The total heat generated by the combustion that has taken place.
2.—The weight of gases—either products, diluents, or uncombusted gases—that hold this heat.
3.—The specific heat of these gases at the temperature attained in the flame.

Undoubtedly, very useful relative figures may be obtained if such calculations are made. They are chiefly useful as indicating the conditions that will affect the temperatures attainable. The phenomenon of flame is not observable except when gases and vapours are undergoing combustion. It is, therefore, composed of the hot vapours and gases undergoing combustion, and frequently diluted with inert gases and products. The experiments made by Smithells and Ingle (1892) are particularly interesting and useful in the light they throw on the structure of flames.

Complete Combustion.

As has already been indicated, complete combustion, even in explosion, is never instantaneous. The presence of any foreign gas interferes with combustion. Every portion of flame must contain combustible, burning and already burnt substances. A certain space is required, and the temperatures will be unequal in different parts of it. The following are some of the factors that cause the actual temperatures attained in flames to diverge widely from those calculated.

1.—Combustion is not instantaneous, and not confined to one spot.
2.—The reaction $H_2 + O \rightarrow H_2O$ is a reversible one at high temperatures. A different state of equilibrium exists between H_2, H_2O, and O_2 at each temperature; and, consequently, heat is not only being generated but it is being absorbed.
3.—The specific heat of certain gases increases considerably at high temperatures. Holborn and Austin have shown that—

Between	110° C.	and	280° C.	the mean specific heat of steam		is	·465, while
,,	110° C.	,,	1400° C.	,,	,,	,,	·532, and
,,	110° C.	,,	200° C.	,,	,,	CO_2 ,,	·217, while
,,	110° C.	,,	1400° C.	,,	,,	CO_2 ,,	·272, and
,,	110° C.	,,	200° C.	,,	,,	N_2 ,,	·240, while
,,	110° C.	,,	1400° C.	,,	,,	N_2 ,,	·262.

As the temperature found in different parts of the flame is known to vary very considerably, it is impossible to take an accurate figure for any of these specific heats.

4.—There is an appreciable loss of heat by radiation—perhaps amounting to 10 per cent. in an average coal gas bunsen flame.

If none of these variations occurred, the temperature of detonating gas ($H_2 + O$) would be calculated as 7700° C. It is most nearly 2000° C.

When any but theoretical quantities of gases for the complete combustion of the gases are present, lower temperatures will be attained. Flames of coal gas and oxygen in theoretical proportions will have higher temperatures than flames of coal gas and air. In the latter case, the nitrogen which is present in large proportions, acts as a diluent and absorber of heat. In a similar way, mixtures in which there is an excess of gas will produce flames of lower temperature than correct mixtures—the excess of gas acting as a diluent.

Where gas and air are used, the highest flame temperatures are obtained when a correct and efficient mixture of air and gas is made previous to combustion commencing—assuming for the moment that the question of preheating either is out of consideration. These correct mixtures may be obtained either by means of high-pressure gas and injected atmospheric air or by means of air under pressure and low-pressure gas. We find that the most constant conditions are given by the former of these methods.

Reverting back to the original proposition, then—that of soft metal melting in iron pans—the highest efficiencies are obtained by means of the apparatus described, using high-pressure gas and chamber burners. The reasons are as follows. The combustion space is reduced to a minimum. The high velocity of the mixture of air and gas in contact with the pot clears away the inert gas film that reduces the head of heat in the flame. The temperature of the "air coal-gas" flames is at a maximum because the mixture is complete before combustion takes place, and there are no diluents in the flames due to excess of air or gas. [Very little secondary air is necessary.]

Compare these conditions with those found when using the best types of industrial low-pressure ring-burners. The flame temperatures are from 200 to 300° C. lower than high-pressure flame temperatures. The temperature "head" is consequently much lower. The velocity of the gases that escape from the burner is not high enough to interfere with the pad of inert gases round the pot. After very exhaustive experiments, we find that, working with a pot as shown in fig. 1, containing 3 cwt. of white metal, it is possible to maintain the metal at 650° Fahr. with a consumption of 165 cubic feet of high-pressure gas per hour; whereas it takes 250 cubic feet of low-pressure gas to do the same work. By means of low-pressure gas, it was found impossible, whatever the consumption, to attain a temperature in the metal of 800° Fahr.; whereas there was no difficulty in doing this with high-pressure gas. With a larger quantity of metal, 2 tons, in a larger pot, even 600° Fahr. could not be attained by means of low-pressure gas-flames.

Indirect Heating.

It has already been stated that for the purpose of the present discussion heating by means of gas may be considered as (1) direct (flame) and (2) indirect (radiation). In most heating appliances both systems are employed; but where the best results are to be obtained, it is necessary to distinguish between them in order that each may be manipulated and adjusted as best suits the conditions to be fulfilled. In crucible furnaces, by far the greatest part of the heating of the pot is by radiation from the furnace walls; but some heat is also conveyed to the pot from the flame and the hot products encircling the pot. In glory holes and ovens, the whole of the heating is by radiation, as the products do not come into contact with either the metal to be heated or with the pot, where one is used.

Radiant heating, though indirect, is the more efficient if the furnace linings are satisfactorily made and the minimum amount of heat is allowed to escape through the furnace walls.

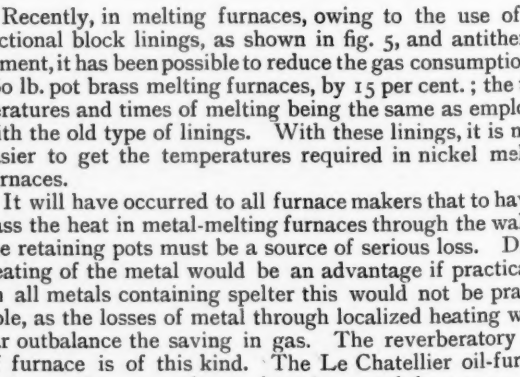


Fig. 5—Sectional-Block Furnace-Linings.

Recently, in melting furnaces, owing to the use of the sectional block linings, as shown in fig. 5, and antithermic cement, it has been possible to reduce the gas consumption, in 160 lb. pot brass melting furnaces, by 15 per cent.; the temperatures and times of melting being the same as employed with the old type of linings. With these linings, it is much easier to get the temperatures required in nickel melting furnaces.

It will have occurred to all furnace makers that to have to pass the heat in metal-melting furnaces through the walls of the retaining pots must be a source of serious loss. Direct heating of the metal would be an advantage if practicable. In all metals containing spelter this would not be practicable, as the losses of metal through localized heating would far outbalance the saving in gas. The reverberatory type of furnace is of this kind. The Le Chatellier oil-furnace is in use in many places; but the metal losses must be enormous.

As has been frequently indicated before, the relative advantages of low-pressure gas, air-blast, and high-pressure gas systems depend on the local circumstances and the description of work that has to be carried out. Much experimental work remains to be done in the design of low-pressure gas-heated furnaces. In this type, there are great possibilities for regeneration—in preheating the air used

in combustion. There are very satisfactory furnaces of this type at present on the market.

Surface Combustion.

During recent years much has been heard of this system for gaseous heating. Birmingham is perhaps the city that has most to gain by improvements of this kind, and we had hoped to instal many of these furnaces if the results to be obtained were what we had anticipated, and if the furnaces had been sufficiently lasting in construction to stand the wear and tear of normal works conditions. So far, we have had no evidence of any long-period practical tests on which to judge.

Injectors.

When considering the question of air injection, due attention must be paid to the controlling factors, which may be enumerated as follows:

1.—The amount of air injected will depend upon the mass rate of discharge of the gas through the jet, since, as will be seen later, we depend entirely on the momentum of the issuing stream of gas for imparting the requisite velocity to the surrounding air.

2.—The area of the surface of the gas stream in contact with the air should be as large as possible, consistent with clear injection—namely, that obtained without interference due to eddies brought about by unsatisfactory design of jets.

3.—The entrance to the "vena contracta" should be designed so as to impede, in as small a degree as possible, the passage of the mixture through it; this being brought about by suitable shaping.

4.—The diameter of the "vena contracta" should be such that sufficient velocity of the mixture is obtained to prevent back-firing.

The completeness of the mixture will be largely dependent on the expansion space beyond the "vena contracta." We will assume, for purposes of calculation, that the mixture passes into a zone at atmospheric pressure, although under actual works conditions we shall have a slight back-pressure in the furnace which will tend to reduce the injection. And further, we shall assume that the air to be injected is also at atmospheric pressure, and at rest. Having obtained the pressure of the gas which will produce, at the jet, a velocity which is consistent with the obtaining of the maximum mass rate of discharge, we can then obtain the theoretical volume of air which may be injected by equating the momentum of the gas to the momentum of the mixture. The variations from this figure in practice will be due partly to the imperfect intermingling of air and gas and partly to such effects as friction in the injector throat, and to back-pressure in the burner-tube.

If we assume gas to flow adiabatically from a vessel where the pressure is p_o in pounds per square foot absolute to a place where its pressure is p_1 pounds per square foot absolute, then we find that the velocity of flow of the gas v is equal to

$$\sqrt{\frac{2g}{w_o}\,\frac{\gamma}{\gamma-1}\left(p_o^{\,1-\frac{1}{\gamma}}-p_1^{\,1-\frac{1}{\gamma}}\right)p_o^{-\frac{1}{\gamma}}}\ \text{ft./sec.} \quad \text{(I.)}$$

Where w_o = weight of gas in pounds per cubic foot at pressure p_o

g = Acceleration due to gravity = 32·2 ft./sec. per sec.

γ = Ratio $\dfrac{\text{specific heat at constant pressure}}{\text{specific heat at constant volume}} = \dfrac{C_p}{C_v}$

—*i.e*, weight of gas which will flow/sec. through an orifice A. sq. ft. providing we have no friction

$$= A \times \sqrt{\frac{2g}{w_o}\,\frac{\gamma}{\gamma-1}\left(p_o^{\,1-\frac{1}{\gamma}}-p_1^{\,1-\frac{1}{\gamma}}\right)p_o^{\,\frac{1}{\gamma}}} \times w_1 \quad \text{(II.)}$$

$$\text{and } w_1 = w_o\left(\frac{p_1}{p_o}\right)^{1/\gamma}$$

Thus w = quantity of gas flowing per second in pounds

$$= A\sqrt{\frac{2g\gamma}{\gamma-1}\,w_o p_o\left\{\left(\frac{p_1}{p_o}\right)^{\frac{2}{\gamma}}-\left(\frac{p_1}{p_o}\right)^{\frac{\gamma+1}{\gamma}}\right\}}$$

For the weight flow per second to be a maximum we have:

$$\frac{p_1}{p_o} = \left(\frac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma-1}} \quad \text{(III.)}$$

$$\text{or } p_1 = p_o\left(\frac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma-1}}$$

Substituting this value for p_1 in the equation given above for v, we get v_1 = limiting velocity for maximum mass-rate of discharge $= v_1 = \sqrt{\dfrac{2g}{w_o}\,\dfrac{\gamma}{\gamma+1}\cdot p_o}$ ft./sec. (IV.)

From (III.) we have (for coal gas of density ·48, and $\frac{c_p}{c_v} = 1{\cdot}33$)

$$\frac{p_1}{p_o} = \left(\frac{2}{2{\cdot}33}\right)^{4{\cdot}03}$$

$$\text{or } p_1 = {\cdot}540\, p_o$$

Substituting this value in equation (IV.) and taking p_1 = atmospheric pressure, we have:

$p_o = \frac{1}{{\cdot}54}$ atmospheres

$g = 32{\cdot}2$

$\gamma = 1{\cdot}33$

$w_o = \frac{1}{v_o}$ where v_o = volume per pound at pressure p_o

also $p_o v_o = RT_o \therefore v_o = \dfrac{RT_o}{p_o}$ or $w_o = \dfrac{p_o}{RT_o}$ where R = J $(c_p - c_v)$ and T_o = absolute temperature

$$R = 110 \therefore w_o = \frac{1}{{\cdot}54} \times \frac{14{\cdot}7 \times 144}{110 \times 521} = {\cdot}0684$$

$\therefore$ Limiting velocity $v_1 =$

$$\sqrt{\frac{64{\cdot}4}{{\cdot}0684} \times \frac{1{\cdot}33}{2{\cdot}33} \times \frac{14{\cdot}7 \times 144}{{\cdot}540}} = 1450 \text{ ft./sec.} \quad \text{(V.)}$$

Thus it will be seen that the limiting velocity of such a gas, for an adiabatic flow, if the condition of maximum mass rate of discharge holds, amounts to 1450 feet per second, which velocity will be obtained with a gauge pressure of 25·5 inches of mercury if the discharge is into atmosphere. This fact will incidentally explain why fittings, cocks, &c., if capable of withstanding this pressure of gas, are satisfactory for working at considerably higher pressures. It will be at once understood that from an injection point of view, the most economical results will be obtained when the mass rate of discharge from the gas jet is a maximum.

Let us suppose that a stream of gas having velocity v_1 comes in contact with air at rest near an orifice through which the flow is guided. Then assuming that there is no frictional loss through the orifice, and that perfect intermingling of gas and air takes place if V = velocity with which the combined stream will pass through the orifice.

Then $V = \dfrac{v_1}{1+y}$ where $y = \dfrac{\text{weight of air passing per second}}{\text{weight of gas passing per second}}$

Then if K = sp. gr. of gas (air = 1).

Then the $\dfrac{\text{air}}{\text{gas}}$ ratio theoretically obtainable for a gas velocity v_1 and mixture velocity $V = Ky = K\left(\dfrac{v_1}{V} - 1\right)$

Taking v_1 = 1450, corresponding to a pressure of 25·5 inches of mercury (gauge)

and V = 45 feet per second

and K = ·48. Then theoretical $\dfrac{\text{air}}{\text{gas}}$ ratio obtainable

$$= K\left(\frac{v_1}{V} - 1\right)$$

$$= {\cdot}48\left(\frac{1450}{45} - 1\right)$$

$$= 14{\cdot}98$$

In practice, the figure obtained is very much lower, owing, in the first place, to the fact that the friction effect between the stream of gas and the surrounding air is not sufficient to obtain perfect intermingling; and, secondly, owing to the pressure in the throat of the injector not being atmospheric, as is supposed. Many methods have been tried for bringing about a better mixing of gas and air, among which are the multiple cone and the multiple jet. In the case of both these systems, however, it was found that eddies were produced in the injector throat, and, owing to the back-pressure thus brought about, the single jet was found to be more satisfactory. We find that, in the case of high-temperature furnaces, where gas is used at a pressure of about 12 lbs. per square inch, a mixture velocity of about 45 feet per second gives excellent results.

Table I. shows the results of a series of tests carried out

TABLE I.

Type of Burner.	Gas Consumption Cubic Feet Per Hour.	Working Pressure.	Air/Gas Ratio of Mixture.	Velocity of Mixture at Burner Mouth. Feet per Second.	Volumes o. Secondary Air Required per 1 Vol. of Gas for Complete Combustion.	Remarks.
High-pressure chamber burner fitted with ¾-inch Keith injector	49·0	24 in. mercury	3·7	10·0	1·6	Aëration only sufficient to obtain stable flame at mouth of burner
Ditto.	Do.	Do.	8·0	19·3	—	Maximum air injection.
"S.-W." furnace burner . . .	250	24 in. mercury	10·1	112	—	Jet in position for maximum air injection.
Standard type cast-iron ring-burner	51·8	2 in. water	3·3	4·2	1·1	Flame just stable. Maximum aeration.
Ditto.	Do.	Do.	4·0	4·9	·4	"Lighting-back" just taking place.

with several standard types of low-pressure and high-pressure gas-burners, with the object of determining—

(*a*) The $\frac{\text{air}}{\text{gas}}$ ratios obtained in the mixing chambers.

(*b*) The velocities of the mixture at the burner mouth.

(*c*) The $\frac{\text{air}}{\text{gas}}$ ratio of the mixture, when "lighting-back" of the low-pressure burners occurred.

In each case, the $\frac{\text{air}}{\text{gas}}$ ratio was determined from an analysis of the mixture; and the theoretical $\frac{\text{air}}{\text{gas}}$ ratio for the complete combustion of the gas used was 5·3.

Application of Gas to Glass Manufacture.

A considerable amount of experimental work has been recently carried out in Birmingham in connection with the application of town gas for glassware manufacture; and as a result several large manufacturers have adopted gas for heating their lehrs, glory holes, and sand kilns. Several melting furnaces and tanks are also about to be installed. We have recently installed in one glass-works twelve glory holes, ranging from 42 inches to 8 inches diameter, all of which are heated by means of town gas at a pressure of 12 lbs. per square inch, and also two lehrs, which are supplied with gas at the ordinary pressure of about 20-10ths of water. The glory holes consist essentially of massive brickwork settings having cylindrical cores of diameters to suit the particular requirements—these varying from 8 inches in the case of the smaller holes, suitable for such work as tumblers, wine-glasses, and small glass articles, up to 42 inches, as would be required for the larger work, such as glass shades, large bowls, &c.

The general arrangement of these holes will be best understood from figs. 6 and 7, the latter representing a section of such a hole. The burners B, which simply consist of injectors to which are attached short lengths of 1-inch pipe, enter the hole at a tangent to the inner lining, which is rough-cast with ganister and broken brick, so as to present as large as possible a heating surface to the flames; the back wall of the

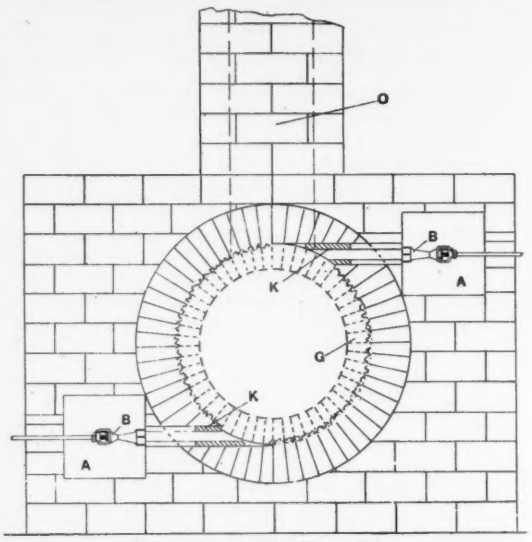


Fig. 7.—Gas-Heated Glory-Hole.

hole also being treated in the same way. The ends of the burner tubes are built into clay nozzles K, which prevent the tubes from being burnt away. The primary air is drawn preferably through air flues A, which pass through the outside walls of the building; this arrangement considerably

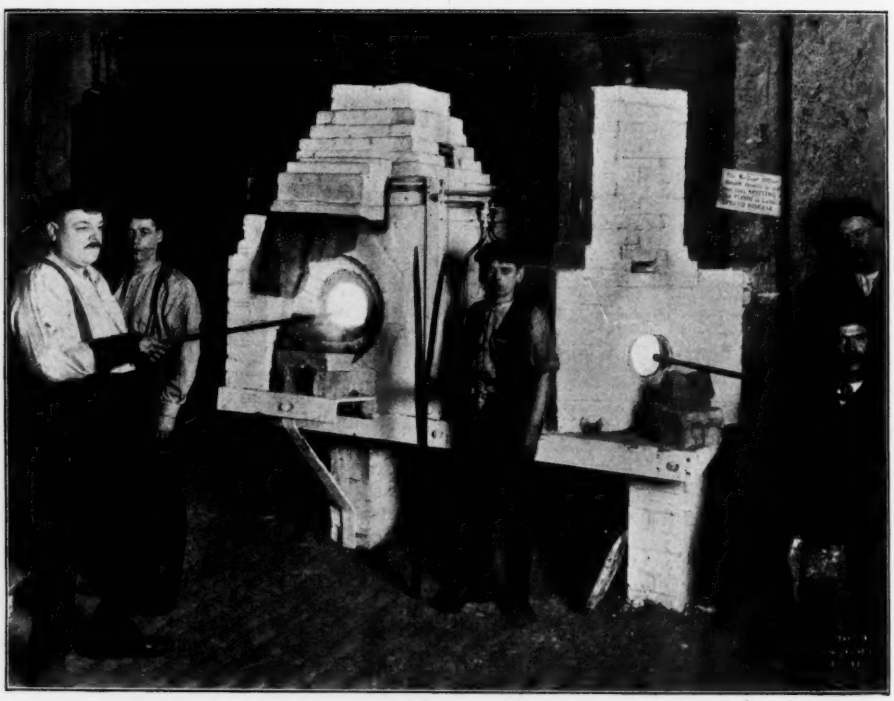


Fig. 6.—GAS-HEATED GLORY HOLES.

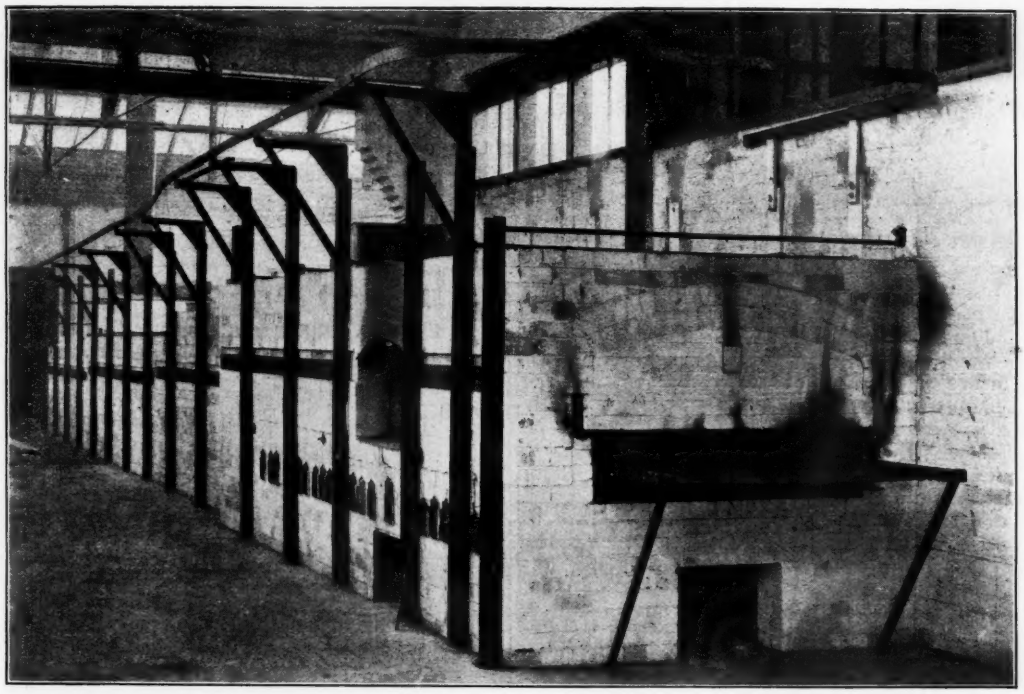


Fig. 8—GAS-HEATED GLASS-LEHR.

reducing the large amount of noise which would be produced if the injectors were simply open to the atmosphere. G is an annular brickwork fence placed at the front of the hole to prevent the flames issuing from the mouth. It is composed of ordinary sector fire-bricks. The depth of the fence varies from 6 inches to 2 inches, according to the size of the hole. As previously stated, the whole of the interior is rough-cast with a mixture of best quality ganister and broken brick.

In the case of the larger holes, the broken brick used is about 1 inch in diameter; while in the case of the smaller holes, broken brick, about ¼ inch diameter, is mixed with the ganister and then rammed tightly over the whole interior surface of the hole. The size and number of burners required varies, of course, with the size of the hole; but it is found that the most convenient unit to use is one having a consumption of about 160 cubic feet per hour.

For holes having diameters from 36 inches to 42 inches, four such burners are required. These are placed in pairs, entering at the front end of the hole, as indicated in figure; while the flue outlet is situated at the back. For holes up to 16 inches diameter, two such burners are found to be sufficient; these entering tangentially at the front, as previously explained. In the case of small holes, from 6 inches to 8 inches in diameter, one burner is found to be sufficient; this being arranged, preferably, to enter the hole tangentially at the back, in which case the flue outlet would be situated at the front of the hole.

It is found that with a gas pressure of about 12 lbs., no secondary air is required—sufficient primary air being injected to obtain complete combustion. The usual working temperature is about 1400° C.; but temperatures as high as 1500° C. have been obtained. As regards fuel cost, it is found that, with gas at 1s. 2d. per 1000 cubic feet, it works out to be about equal to that obtained with solid fuel. But the advantages obtained with such a system, as compared with a system of heating by means of solid fuel, will be at once apparent.

At this point we wish to mention a difficulty which arose in connection with the working of flint glass. Considerable trouble was at first experienced when dealing with glass containing a high percentage of lead, owing to the "sulphuring" effect produced by the gas. This was eventually found to be entirely due to the presence of a naked flame in the hole, and was completely overcome by causing the combustion of the gas to be concentrated on the lining of the hole, thus eliminating any naked flame from the centre.

Gas Heated Lehrs.—The lehrs referred to above are each 70 feet long by 5 feet wide, internal dimensions; the depth from the centre of the crown of the arch to the pan level being about 2 ft. 6 in. The general arrangements will be seen from figs. 8 and 9, the latter representing a cross section of the lehr. These were constructed on a reinforced concrete floor R, in the upper story of the building; the atmospheric burners B being arranged in two rows as shown, with their respective gas supplies S fixed in the room beneath. The combustion chamber extends for a length of 15 ft. 6 in.; the remainder of the furnace being heated by means of the waste gases.

As will be seen, the burners are arranged in two rows, one on either side of the centre of the furnace; each burner being provided with an independent secondary-air flue A. The flames play into the combustion chamber C, which consists of a rectangular space, 2 inches wide by 15 ft. 6 in. long by about 3 feet in height, which is bounded on the inside by a 2-inch wall built up of special rebated panelled

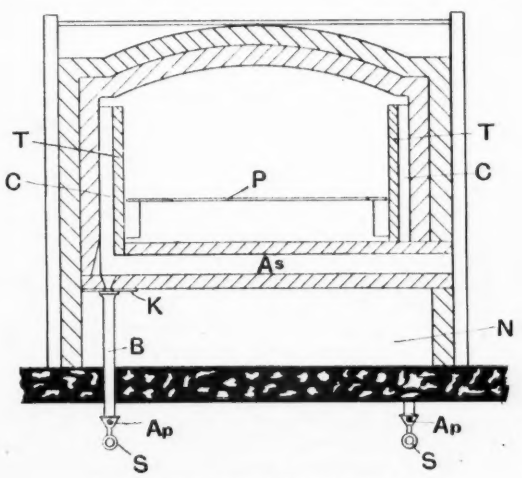


Fig. 9—Section through a Gas-Heated Lehr.

tiles, and on the outside by the outside wall of the furnace itself. The waste gases pass out at the top of this chamber, and then down along the lehr to the flue outlet situated at the other end.

It will be noted that all the secondary-air inlets are arranged on one side of the furnace; this being necessary, as the opposite side was closed in. It will be further observed that these secondary-air flues are so arranged as to expose as large a heating surface as possible to the interior of the furnace itself. This system of pre-heating the secondary air, though not strictly speaking recuperative, is, nevertheless, found to materially increase the furnace effi-

ciency, and at the same time give good distribution of heat which is so essential when dealing with glass work.

Below the secondary-air flues is constructed an air-chamber N, the object of which is to prevent loss of heat from the bottom of the furnace by conduction. The pans P are placed on runner rails fixed about 10 inches above the top of the tiles covering the secondary-air flues. The burner spacing in plan averages some 15 inches from centre to centre; the burners not being arranged symmetrically on either side of the centre of the furnace, owing to a door having to be arranged for on one side at the charging end. The total number of burners amounts to twenty—nine being placed on one side and eleven on the other side; each burner being designed to have a maximum consumption of 75 cubic feet per hour when working at a pressure of 20-10ths of water. The burners are supported by means of cast-iron anchor plates K, which are rigidly built into the brickwork foundations.

The results obtained with these lehrs have proved to be most satisfactory in every way. The fuel cost compares favourably with that obtained in the case of coal firing, and, at the same time, the breakages are considerably reduced, owing to the more uniform heating obtained. Added to these, of course, we have the further advantages due to the reduction in the wear and tear of the furnace itself, the simplicity of regulation, and the cleanliness of such a system—all of which appeal strongly to the glass manufacturer. These lehrs can be raised to a working temperature of about 1500° Fahr. in about three hours from cold, with a gas consumption of about 1000 cubic feet per hour. After this, the working temperature may be maintained with a consumption of 700 to 800 cubic feet per hour according to the class of work to be dealt with.

Glass Melting Furnaces.—Experiments have also been recently carried out in connection with the melting of glass itself. Bottle glass has been melted by means of high-pressure gas in tank-furnaces; the metal being planed from the raw cullet and batch with every satisfaction. Flint glass has also been melted in pots. To obtain economical results in this application, however, it is found that regenerative settings must be used. Other applications of gaseous heating in connection with glass manufacture include glass-bending furnaces and sand-drying kilns; both these processes having been carried out on a large scale, and proving to be commercially satisfactory.

Tempering, Hardening, and Annealing Furnaces.

In hardening, annealing, and tempering furnaces, we have to consider processes where a large amount of heat at a moderately low potential is required. It must be remembered that this soaking process necessarily requires a big body of heat. With regard to the annealing of brass and steel stampings, it was at one time quite a prevalent idea among manufacturers that no such work could be carried out unless in a closed muffle; it being maintained that were such work carried out in furnaces of the oven type, the oxidation of the work would be excessive. This might be the case if furnaces fitted with air-blast burners were under consideration. With the development of the oven furnace fitted with atmospheric burners, however, all such ideas have long become exploded; and it is now an established fact that, for best results to be obtained, the oven furnace must be used for this purpose.

In the oven furnace with the bottom slab heated by the large flames from atmospheric burners, we obtain just the effect that is required by these soaking processes; the poorly aërated flame which partly envelopes the work being an absolute necessity for the best results to be obtained. Further, if suitable arrangements are made to enable the amount of secondary air entering the furnace to be controlled, then the work can be carried out with a minimum of oxidation; for it will be understood that if such a furnace be run with the damper so adjusted that a slight back-pressure is obtained, and if the amount of secondary air entering the furnace is only just sufficient for complete combustion of the gas, then the work is continuously sealed from the atmosphere by means of the products of combustion with which it is surrounded.

Fig. 10 represents a furnace of this type suitable for annealing purposes, and also for the tempering and hardening of steel, case-hardening, and all such processes which require this soaking effect at any temperatures up to 1200° C.—this temperature being maintained quite easily with a gas pressure of 3½ to 4 inches water-gauge. It will be seen that the burners B are arranged in a line entering the bottom of the furnace in the centre. The whole of the secondary air being admitted through the flues A and controlled by the dampers D, combustion takes place in the chamber C, beneath the floor of the furnace F; the waste gases passing into the oven itself through nostrils at the sides, and finally entering the flue outlet O. It will be observed that the secondary-air flues A are so arranged that a considerable preheating effect is obtained; and although such a system

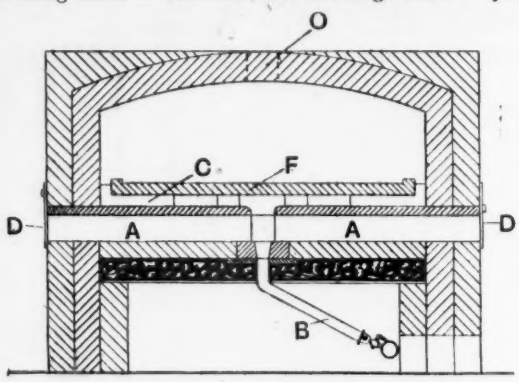


Fig. 10—Section through a Gas-Heated Oven-Furnace.

of preheating may not be considered either as regenerative or recuperative by reason of the heat supplied to the secondary air not being abstracted directly from the waste gases, the net results obtained with such a system are, nevertheless, much the same, as a certain amount of heat is being continually transferred by means of the secondary air from the oven slab to the sides and roof, which results in very uniform heating being maintained throughout the whole of the working space.

As regards the working pressures suitable for this class of work, the results of a considerable number of experiments show that—disregarding for the moment the time taken for the preliminary heating-up of the furnace—no advantage is obtained when working with pressures higher than 4 inches of water-gauge. With this pressure, temperatures up to 1200° C. can be maintained. The best results are obtained when the aëration is only just sufficient to allow the required temperature being maintained—that is to say, the volume of the flame should be a maximum for the temperature required. Furnaces of this type are particularly suitable for the annealing of brass and steel stampings, where temperatures of from 800° to 950° C. have to be maintained; also for the case-hardening of steel, where temperatures up to 1100° C. are required. As regards case-hardening, it will be found that little or no carbon absorption will take place at temperatures below 900° C.; the best results being obtained by soaking at as low a temperature as possible for a long period, rather than working at a higher temperature for a shorter period.

For normal carbon steels, it is usual to case at a temperature of about 1050° C.; quench when the required depth of casing has been obtained; re-heat to a temperature of about 950° C.; and quench again finally in oil or water, according to the particular degree of hardness required. For both the processes of case-hardening and re-heating this type of furnace is admirably suited.

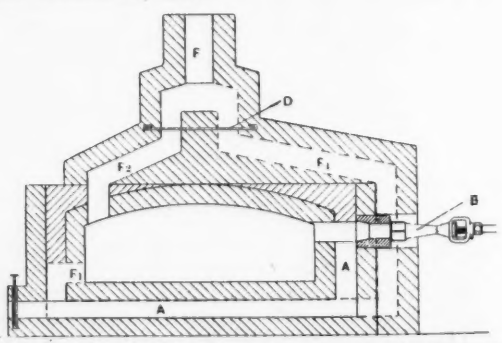


Fig. 11—Section through a Regenerative Reverberatory Furnace.

Fig. 11 represents a section through a regenerative reverberatory furnace, suitable for use with either low-pressure or high-pressure gas; the working pressure depending on the temperature required. It will be seen that the burners B are placed in a line, entering the side of the furnace, and

so arranged that the flame impinges on the arch; the waste gases passing over the work, and hence into the flue outlet F_1, situated at the bottom on the opposite side, whence they are conducted beneath the furnace bed into the main flue F, giving up their heat to the secondary air, which passes through the flues A, arranged alternately with the waste-gas flues beneath the furnace bed. It will be further observed that an auxiliary flue outlet F_2 is provided. This is necessary to prevent any short-circuiting taking place when the furnace door is opened; the dampers being so arranged that, when the furnace door is opened, F_1 is closed and F_2 opened simultaneously.

Furnaces of this type are very suitable for any class of annealing operation where the work itself does not offer an obstruction to the flames—such as plate annealing and the annealing of stampings. Temperatures up to 1500° C. may be obtained with a working pressure of about 100 inches water. A similar design of furnace may also be adopted for forging, welding, and the hardening of high-speed steels.

General Furnace Construction.

When considering the mechanical design and construction of gas-furnaces, the conductivity of fire-clay is of extreme importance. In large muffles and ovens, in which a big body of heat is required, particular attention must be paid to the conductivity of the fire-brick employed, so that the thickness of wall to give the most economical working may be determined. There are, of course, many factors to be taken into account when considering the question; but it will be easily understood that, in the case of small furnaces which are used only during the day, and therefore require to be heated-up to a working temperature each morning, the time required for this preliminary heating-up will to a great extent depend upon the thickness and conductivity of the walls. In such cases the amount of brickwork should be a minimum; a 4½-inch brick, backed up by a good non-conducting material, well cased round preferably with wrought plate, being all that is required. The lining, however, should be as non-conductive as possible, so that the radiation losses are reduced to a minimum.

Coming to the larger furnaces of this type—say, over 3 ft. 6 in. in width—it will, in most cases, be found that, owing to the large amount of heat absorbed by the brickwork in the preliminary heating-up, the more economical method of working is to arrange for a small number of burners to be kept on continuously—maintaining a temperature of not less than 600° C. in the furnace during the period in which no work is being carried out. With such a system of working, there is not only a fuel economy to be obtained, but the maintenance cost will be considerably reduced. For very large muffles and ovens which are working continuously, the thickness of wall should not be less than 14 inches—9 inches at least of which should consist of best quality fire-brick material. The general method of staying-up these large furnaces with buckstays and cross plates is quite satisfactory; there being no need in such cases for any metallic casing.

In the case of furnaces for melting brass, bronze, nickel, and aluminium, the arrangement shown in fig. 5 is found to give extremely good results. It will be noted that the furnace lining itself is built up of specially-moulded bricks forming a block, square in section, having a cylindrical core of a diameter to suit the particular size of pot used. This lining is made in nine sections, including the flue cover tile T. The sections are placed in position and luted together at the luting grooves L, provided on the face of each section. The furnace case C consists of a box constructed of cast-iron plates all loosely held together by stays as shown. The box is first lined with a 4½-inch wall B of fire-brick, leaving a space of about 2 inches between the wall and the lining itself, which is filled up with a non-conducting material P, such as asbestos cement.

The advantages obtained by the use of sectional linings of this type are many. In the first place, the wear and tear is considerably reduced, owing to the few joints and the consequent small amount of jointing material requisite; the linings can be quickly renewed by an inexperienced workman; and, lastly, the cost of relining the furnaces with such linings is considerably less than in the case of linings built-up of sector bricks. The mechanical advantages of such a lining, due to the increased strength round the burner apertures, will also be understood.

In dealing with the mechanical construction of melting furnaces, it is most important that provision should be made for the bottom of the furnace being so constructed that it can be removed and re-made as expeditiously as possible, as the successful working of such furnaces depends to a great extent on the maintaining of the bottom free from spilt metal, which is not only liable to cause blocking-up of the burner passages, but also considerable damage to the furnace lining itself, owing to its fluxing effect with the fire-brick. This arrangement may be very efficiently carried out by arranging for the bottom plate to be fitted with a circular cast-iron flange plate having the same diameter as the lining itself; this plate being held in position by two drawbars passing through projecting lugs cast on the underside of the bottom plate. [The furnace itself should be built on brick piers arranged at a convenient height.] On the top of this flange-plate, the furnace bottom is placed. This consists of a mixture of broken fire-brick and ganister well rammed to a depth of 2½ to 3 inches. Should the bottom be required to be renewed, all that is necessary is for the drawbars to be withdrawn and the flange plate removed. The fire-clay bottom may then be dropped out with the aid of a dumping rod from the top of the furnace, and any spilt metal recovered with a minimum of trouble. To obtain the best results, it is essential that the rebottoming of all such furnaces should be carried out at least once a week.

The proper dimensioning of the lining is of the greatest importance if high temperatures, efficient working, and low metal losses are to be obtained. The diameter of the lining is generally determined from practical considerations; it being remembered that pot tongs must be accommodated. It may, therefore, be taken as a rule that the diameter should be sufficient to allow of a clearance of about ½-inch over the maximum dimensions of the pot tongs used, though in cases where the pots are not removed from the furnaces this figure can be reduced with advantage. In no case, however, should the dimensions given above be exceeded, if the highest efficiencies are to be obtained.

The height of the furnaces is again to a certain extent determined from practical conditions—this depending upon the nature of the metal to be charged in. To obtain the minimum metal loss, however, there should be at least a depth of 6 inches above the rim of the pot in the case of furnaces up to 80 lbs. pot capacity, and of 10 inches as in the case of the larger pots; the bottom of the flue outlet being slightly higher than the rim of the pot.

Burners should be arranged to enter the furnace tangentially to the annular space between the pot and the lining, and arranged on opposite sides where possible. For small melting furnaces up to 80 lbs. pot capacity, a single burner will suffice. In the case of the larger sizes, however, two or more burners should be used, placed on opposite sides as shown.

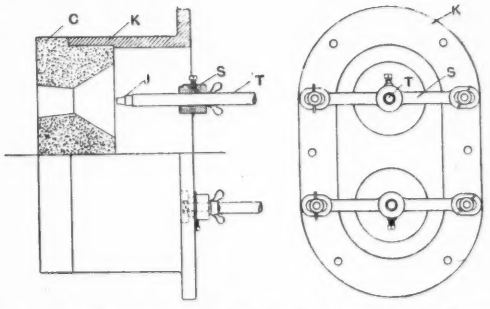


Fig. 12—New Pattern "S.W." Duplex High-Pressure Gas-Burner.

Fig. 12 represents a section of the new pattern "S.-W." duplex high-pressure burner; this having been designed to meet the requirements for the melting of nickel and high copper alloys. K is an oval cast-iron thimble flanged to fit into cores cast in the side plates of the furnace. This thimble supports a massive duplex fire-clay core-brick C, the nose of which fits in a recess moulded in the specially designed linings referred to above. The burner tubes T, carrying the jets J, are supported in cast-iron stirrups S, which are bolted to the flange of the thimble; these stirrups being slotted so that the jets may be adjusted to coincide with the centre lines of the injector cones. This was found necessary to accommodate slight variations which take place in the manufacture of the clay cones.

Fig. 13 represents a section through a high-pressure gas-heated soldering-iron stove which has recently been placed

on the market, designed for heating two copper bits and working with a gas pressure of about 80 inches of water. The burner B enters the lining S in the centre underneath, the flame striking the fire-clay projection at the top, where it is divided-up—one half passing round each iron; the products passing out at the bottom of each small combustion chamber into the flues O, and thence to the outlet.

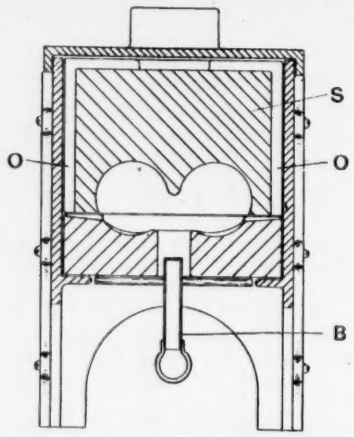


Fig. 13—High-Pressure Soldering-Iron Stove.

It will be noted that a slight recuperative effect is thus obtained. These stoves are found to give very good results, and compare in running costs very favourably with coke-heated stoves. With a consumption of 14 cubic feet of gas per hour they are capable of heating up two 3½-lb. bits from cold to a working temperature in twelve minutes. A lengthy test with a number of stoves shows that, as compared with the usual coke-heated stove, there is not only a fuel economy obtained, but the further advantage that the bits require re-tuning only once a day, whereas in the case of coke-heated stoves this process was carried out, on the average, once each hour. The saving thus effected in copper is considerable.

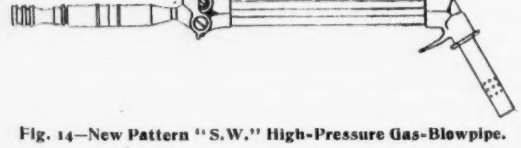


Fig. 14—New Pattern "S.W." High-Pressure Gas-Blowpipe.

Fig. 14 represents a new pattern "S.-W." high-pressure gas blow-pipe. A description of the working of this pipe has already been given on a previous occasion; but it will be noted that the control arrangement has been considerably simplified; the whole of the regulation now being effected by means of the two small levers, while at the same time the weight has been considerably reduced.

Gas Compressing Plant.

Where consumers are not in a position to obtain a supply of high-pressure gas directly from the mains, it becomes necessary for gas compressing plant to be installed on the consumer's premises. The following particulars, may in such cases, be of some service. In the first place, we have to determine at what pressure the gas is required to be compressed, and whether it will be necessary to instal plant of the rotary or reciprocating type. It has long been proved that rotary compressors can only be used where the working pressures do not exceed 5 lbs. per square inch, but even at this pressure, if a large output is required, it will pay to instal reciprocating plant by reason of its greater mechanical efficiency. Thus we may preclude rotaries, except for cases where a relatively small consumption is required at a pressure of (say) 2 to 5 lbs. per square inch.

With regard to reciprocating plant, the compressors used must be of first-class workmanship throughout, and have a high volumetric efficiency. At this point also it would be well to mention that most of the machines primarily designed for air compressing are quite unsuitable for gas work, unless considerable modifications, such as will be shown later, are made. In cases where the compressor itself has to be installed in or near to a foundry, it is obvious that the machine should be of the enclosed, self-lubricating type, in order that its working parts shall not be subjected to undue wear owing to the presence of sand, grit, and other foreign matter. Many excellent machines of this type are now procurable, most of which are of the high-speed vertical type with completely enclosed crank-shaft.

In cases, however, where the compressor may be placed in a position free from grit, &c., the ordinary horizontal slow-revolution fork-frame machines are very suitable. We might mention that machines of the single-cylinder single-acting type have been found to be quite unsuitable for gas compressing—in the first place, because of the serious leakage which always takes place round the trunk pistons, and, secondly, owing to the magnitude of the pulsations set up by them on the gas supply, together with the consequent disturbances on the meter. Multi-cylinder single-acting machines may be used with advantage, providing that the open ends of the cylinders are fitted into an enclosed gas-tight crank chamber, any leakage into which may be piped back on to the low-pressure side of the system.

Systems of Pressure Control.—The methods adopted for obtaining a constant pressure at the receiver with a fluctuating load on the delivery pipe are as follows:—

(*a*) By bye-passing the excess gas back on to the low-pressure side.

(*b*) By unloading the compressor on the suction side when the pressure in the receiver rises above some predetermined limit.

The operation (*a*) is performed by bye-passing the inlet and outlet of the compressor and inserting in this bye-pass pipe, a relief-valve set to open when the required pressure has been reached. This system, while having the advantage of being simple, is efficient only in cases where the load is varied momentarily, as it will be understood that by its use the compressor is taking its full power whatever may be the load on it.

The operation (*b*) is performed by inserting a specially constructed valve on the suction side of the compressor, which valve is operated by the pressure in the receiver. Should the load on the delivery from the receiver be temporarily reduced, this unloading valve will partially shut-down, and the compressor will only take in an amount of gas proportional to the consumption on the outlet; the driving power being reduced accordingly. Should, however, the load on the outlet be completely removed, the unloading valve will shut-off completely the supply of gas to the compressor, which, owing to the vacuum so produced on the suction side, now runs under a friction load only. On the load coming on again, the unloading valve opens, and the compressor takes gas again in the ordinary way.

It will be observed that with such a system, as compared with a bye-pass valve, a considerable saving of energy is effected if the load on the outlet varies within considerable limits. Should the load factor of an installation be less than 60 per cent., an unloader should always be fitted, as with a bye-pass system working under such conditions not only would the expenditure of energy be abnormal, but the temperature rise on the bye-pass system might cause serious trouble.

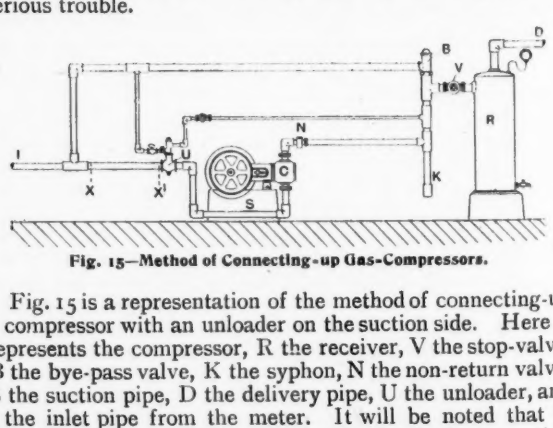


Fig. 15—Method of Connecting-up Gas-Compressors.

Fig. 15 is a representation of the method of connecting-up a compressor with an unloader on the suction side. Here C represents the compressor, R the receiver, V the stop-valve, B the bye-pass valve, K the syphon, N the non-return valve, S the suction pipe, D the delivery pipe, U the unloader, and I the inlet pipe from the meter. It will be noted that in all cases a bye-pass valve must be fitted, whether a suction unloader be used or not. Where a suction unloader is used, however, the bye-pass valve should be set to operate at a pressure slightly in excess of that for which the unloader is set; so that the bye-pass will only come into operation when the small escape which takes place through the unloading valve has caused the pressure in the receiver to be gradually built-up to the bye-pass pressure. It will be easily understood that it is impossible to obtain perfect gas-tightness at the unloader valve, in consequence of which

the pressure in the receiver will gradually rise when the load is wholly removed from the delivery.

Where a bye-pass system is used, provision should be made for bye-pass valves to be fitted in duplicate to allow for emergencies. Further, should it be found necessary for an anti-fluctuator to be used on the inlet to the compressor, this must be inserted between the points marked $X X^1$ on the diagram, in which case both the inlet and outlet valves of the meter must be left full open when the plant is shut-down; so that no building-up of pressure in the anti-fluctuator is possible.

Energy Expended in Gas Compressing.—The energy expended in compressing a given amount of gas may be obtained from the following formulæ, which assumes that the compressing is carried out in a single-stage machine in accordance with the law pv^n = constant, where $n = 1{\cdot}25$; this being the figure generally obtained in practice.

Then work per pound of gas compressed and delivered

$$= \frac{n}{n-1} RT \left[r^{\frac{1-1}{n}} - 1 \right] \text{ foot pounds}$$

where T = absolute temperature in degrees Fahr.

R = $J(C_p - C_v) = 110$ for coal gas of density ·48 (air = 1).

$r = \frac{P_1}{P_o}$ where P_1 = delivery pressure in pounds per square inch, absolute, and P_o = absolute pressure of gas in pounds per square inch entering compressor.

Substituting the above values for coal gas, for a delivery pressure of 12 lbs. per square inch gauge, we shall find that we require 36,335 foot-pounds expenditure of energy for each pound of free gas compressed and delivered at a gauge pressure of 12 lbs. per square inch, or 1,411,000 foot-pounds per 1000 cubic feet of free gas compressed and delivered at this pressure. If we take the mechanical efficiency of the machine as being 85 per cent., and its volumetric efficiency as 85 per cent., then the actual energy required at the shaft of the compressor to compress 1000 cubic feet of free gas per hour and deliver same at a pressure of 12 lbs. per square inch gauge = 0·98 B.H.P., or we may say 1 B.H.P. for each 1000 cubic feet of free gas compressed and delivered at this pressure.

It will be noted that a syphon K is fitted between the compressor and receiver; this being necessary to drain off any of the volatiles which may be condensed owing to the adiabatic expansion of the gas through the valves. It will also be found that a considerable amount of condensation takes place in the receiver itself, on account of which the products should be run off from the drain-tap periodically. The greater part of this condensation is found to take place when the compressor is first started-up, as would be expected, as when the receiver has once been filled the flow of gas would take place practically under isothermal conditions. The condensate referred to will, in most cases, be found to contain a considerable percentage of lubricating oil, which is carried over into the receiver from the cylinder.

Costs of Compressing Gas.—We may take it that for small compressors of a capacity up to 10,000 cubic feet per hour the capital outlay invested in plant will be about £25 for each 1000 cubic feet per hour delivery capacity, and that the total compressing costs, including interest on capital, depreciation, &c., will amount to about 1·75d. per 1000 cubic feet of free gas compressed and delivered at a gauge pressure of 12 lbs. per square inch. This figure being based on the assumption that the compressor is driven from an already existing line-shaft. The approximate running costs of a 10,000 cubic feet per hour plant, running 2800 hours a year with a load factor of 80 per cent., is given below; the cost of the power supplied being taken as 0·75d. per horse-power-hour.

Total cost of plant having delivery capacity of 10,000 cubic feet free gas per hour	£250 0 0
Interest on capital charge, at 5 per cent.	£12 10 0
Depreciation, at 20 per cent.	50 0 0
Cost of renewals, at 2½ per cent.	6 5 0
Oil, waste, stores, &c.	10 0 0
Labour and attendance	15 0 0
Power supplied, taking load factor as 80 per cent. = 22,400 B.H.P. hours, at ¾d. per B.H.P. hour	70 0 0
Total running costs	£163 15 0

Total gas compressed and delivered = 22,400,000 cubic feet.

Total compressing cost per 1000 cubic feet free gas compressed and delivered = 1·75d.

DISCUSSION.

Mr. J. H. Brearley (Longwood): I wish at the outset to give my testimony to the high value of the paper which has been submitted by Messrs. Smith and Walter. I feel that if research into gaseous heating has done nothing else for the gas industry, it did a wonderfully good stroke of business when it attracted to that research Mr. Smith, as the demonstrator and investigator—["hear, hear"]—because, as an outcome, Mr. Smith migrated to Birmingham and is there doing extremely valuable work for the industry in which we are all interested, and which we wish to see prosper. I quite agree with the authors' contention that there should be uniformity in the gas supply, both as to pressure and calorific value. I am afraid it has not yet been sufficiently impressed upon the general body of members that it is one of the greatest essentials, if you are going to secure success in gaseous heating, that the quality of the gas should be uniform. In the paper, there is a statement about the loss of head of heat in a steam-boiler, which is somewhat ambiguous. The authors say that there is at the outset a head of heat equal to 1000° C.; and it is finally reduced, until there is only a head of 100° C. in the water. They say: "It is shown that well over 90 per cent. of this head of heat is lost in its transference through the thin gas film on the fire-box side of the boiler-plate." This would seem to imply that 90 per cent. of the heat was dissipated in this thin gas film. But, of course, the authors intend nothing of the kind. The whole object of heating steam-boilers is to secure loss of head of heat. You want to get the heat transferred into the water. What the authors mean, I think, is that there is a certain loss of head of heat, and of this loss 90 per cent. is taken by the thin gas film on the fire-box side of the boiler-plate. I do not think the authors are quite right when they say that the hottest flame of a coal-gas mixture is obtained when the air is present in quantity sufficient for complete combustion. It certainly is the fact that the highest rate of explosion of mixtures of coal gas and air is obtained with a mixture containing a very slight deficiency of air—that is to say, when there is not quite enough air to completely burn the gas. I think, from this, it follows that the flame temperature will be highest when there is a slight deficiency. I should like to refer to what the authors told us with regard to preheating the air supply for low-pressure furnaces. This may be all right when both gas and air are introduced by means of the drawing action of the chimney; but when the quantity of air is determined by the injecting action of the gas alone, my experience is that the air must be kept as cold as possible, otherwise you will get poorly aërated flames as the result. I think probably the authors have taken the theoretical aspect too seriously, and have not gone into the practical sufficiently in referring to the desirability of preheating the air supply.

As regards the formulæ, I have not attempted to wade through them; but I am assured by one or two makers of gas appliances that they frequently find that formulæ do not coincide with the observations which they have made in the workshop when specifying sizes of injectors, burners, and that kind of thing. I am sorry that we at Longwood have very little heating of this kind. Then as to the "glory holes," if it is not a digression I should like to ask the authors what is the origin of the expression "glory hole." It may be a confession of gross ignorance on my part, but I must confess that until I read this paper I never heard of a "glory hole," and this probably is the experience of many other members.

The few comments I have made must not be taken as detracting from my own personal conviction that in this paper there is an immense amount of sound practical work, which will be useful for the guidance of many members when faced with the question of heating crucibles and other industrial appliances. Finally, there is one regret which I should like to utter, and that is that we have not been able to receive from the authors some more definite information as to surface combustion. I beg to thank the authors for the paper they have brought before us.

Mr. F. W. Goodenough (London): I should merely like to say that I regard the paper that has been presented to us as a very valuable contribution to the text-books of the industry, and as likely to prove a mine of very useful information to those of us who are interested in the question of

advancing the use of gas for industrial purposes. I will not attempt to criticize the paper in any way whatever. I merely wish to say how much I appreciate the work that has been put into it.

Mr. W. A. TWINE (Birmingham): I should like to ask the authers of the paper what type of valve is used for unloading the compressor on the inlet side. I also note that the authors state that rotary compressors should not be used for pressures above 5 lbs. per square inch. I believe there are machines, however, being used up to 10 lbs. May I ask if such machines are mechanically efficient?

Reply to the Discussion.

Mr. E. W. SMITH: I am sorry that the paper has not evoked a more lengthy discussion than it has. Our object in writing it was partly to lay before you for your use —if, indeed, you could find any use in the paper—a few notes on gaseous heating that we thought might be valuable. The secondary object was to create a lively discussion on the question of the quality of gas for heating purposes. The paper was made deliberately provocative; and I had hoped, especially after hearing the speeches at the dinner last night, that there would have been considerable discussion on the quality of gas.

Now, dealing in reply with a few of the points that have been raised by the various speakers, I will come first to what Mr. Brearley has said. He is quite correct in the point he made about the head of heat. What is meant, and what I think is distinctly stated, is that in a boiler-box there is a distinct drop, as pointed out by Professor Dalby in his excellent paper, of what he considers to be 98 per cent. of the head of heat—not of the heat, but 98 per cent. of the drop in the temperature, which, of course, is what is required. That is not the point that I was raising. The point is that there is this drop, and that 98 per cent. of the drop is due to the film of gas which is found on the fire-box side. This, I think, has a very close relation to the effects found in gaseous heating of iron pots. This we find is an explanation of most of the difference found in heating by means of blow-pipe flames, which cover high pressure as well as air-blast and semi-aërated flames, such as low-pressure flames.

As to Mr. Brearley's question in regard to the origin of the expression "glory hole," I do not think he wants to know what it is used for. He wishes to learn the derivation of it. It is difficult to find the actual derivation of the words; but they may have one significance which is obvious, being a very high temperature. [Laughter.] I think the real derivation is to be found in the fact that in some works they spell the words "glowry hole;" but the generally accepted word is "glory."

I am sorry the odd reference that we have made in the paper to surface combustion has not made it possible to have a more lengthy discussion on the subject. We have heard a lot about surface combustion; but so far there has been no discussion on the subject. I think anything that it is suggested will be of value to the industry should be discussed, and not merely papers written on it. So far we have had experience of two or three pieces of apparatus on the surface combustion principle; and though they have given all the efficiency stated, they are not, as remarked in the paper, of the practical utility and lasting type that we in Birmingham find will be adopted by the ordinary works manager, who wants considerable life in any apparatus he is likely to instal. We have not yet found an apparatus of any kind designed on the principles laid down which has appealed to us as being satisfactory. Of course, in high-pressure furnaces it is all surface combustion, and in air-blast furnace also. The same way, chamber and oven furnaces are nothing but surface combustion furnaces. When I speak of surface combustion, I mean in inverted commas.

Mr. Brearley raised the point of the theoretical aspect of pre-heating not conforming to the practice found in various makers' works. We do not present formulæ as the only proof of anything that may be stated. The formulæ are nice to bring out after you have got your facts by experiment. That is the only use, except perhaps in working to get certain results, that we put formulæ to. Anything that is stated in the paper is got distinctly from experiment, and then as an explanation we try to find formulæ to guide you to the next step that may be taken in designing apparatus. I should like Mr. Walter to deal with the question of compressors and pre-heating.

There is one point I wish to add, if I may presume to do so, to what Professor Boys remarked last night. He made the statement that he thought the only standard that should exist for gas was a calorific standard. I should like to add to this that, though it may not be an official standard, there ought to be a recognized standard of flame temperature. It is just as important as a standard of calorific value. I think we shall have to decide soon what is the best average calorific value to provide for the consumer; and the more nearly we can, within a given range, conform to this value, the better for the apparatus turned out by the makers. As I say, we shall have to decide what is the best calorific value to conform to. I know that any given apparatus will work well with a calorific value of either 450 or 550; but in the one case you can only get temperatures of flames considerably lower than in the other. In such cases as mantle heating by incandescent burners, it will make a considerable difference whether we provide a gas of a calorific value of 450 or 550—the flame temperature being so very different. I should like to point out that the flame temperature will have to be considered when a satisfactory standard of calorific value is set up. I thank you, gentlemen, for receiving the paper in the way you have done, and only hope it will be of use to you.

Mr. WALTER: With regard to Mr. Brearley's remarks on the pre-heating of the air, of course, the reference was to the pre-heating of secondary air. I quite agree with Mr. Brearley that in the case of primary air being pre-heated we should not get the requisite mass of air for complete combustion; but the statement in the paper refers in particular to furnaces in which the secondary air passes through pre-heating flues, which in most cases have a good flue pull. We generally have the large furnaces connected up to a main stack sometimes 25 feet high, with manipulating dampers. The statement as to pre-heating air applies only, of course, to secondary air.

With reference to Mr. Twine's question about the type of unloading valve which is used in connection with compressing plant, I may say that we have tried several types of unloaders in connection with this compressing plant, and we found that the most satisfactory result is obtained by a valve which is of the double-beat vertical type, fitted with a piston on the tail-rod—the piston working in a cylinder which is supplied with gas from the receiver. On the other end of the tail-rod is fixed a spring, against which the valve operates. The effect of the pressure acting on the piston is to force the valve down on its seat; and when the pressure is removed by the relief valve, the piston rises and again opens the valve.

As to the question about rotaries, we have carried out a considerable number of experiments in connection with rotary and reciprocating compressors; and we find that, though there are rotary machines which will give pressures up to (say) 10 lbs., they are generally machines which compress in two stages, running perhaps from 1 up to 4, and from 4 up to 10. These machines have to be water-cooled. The mechanical efficiency is very low; and in most cases they are not satisfactory. For this reason, for pressures above 5 lbs. we have always found it more efficient from a commercial point of view to use the reciprocating type, and also in connection with low pressures—say, from 3 to 5 lbs. —if we have to deal with a large quantity of gas.

I thank you, gentlemen, for the way in which you have received this paper, and hope that it will be of some real service to you.

The PRESIDENT: We should all be very sorry, I am sure, if the authors of this paper felt that the shortness of the discussion was due to any want of appreciation of the very high value that we set upon their work. I have heard but one expression with regard to the paper, and that is that it is of very great value to all of us in our work. A remark was made about formulæ not fitting in with the experience of the workshop. I am bound to say that I think there will be less of disagreement in the future than there has been in the past. I feel that this paper will be of peculiar value to many of the members of the Society of British Gas Industries in the preparation and design of their work. The amount of attention to scientific investigation now being given by many manufacturers is one of the best signs of the day;

and the thoroughness with which their work is carried out will be aided, I am quite sure, by much that they will gain from the paper that has just been read. We shall all join in our thanks to the authors.

At the close of the meeting,

Mr. W. NEWTON BOOTH, of the Woolwich Arsenal, handed in the following remarks, which he was unable to make during the discussion on the paper:

I must first of all congratulate the authors of this excellent paper on the very thorough and painstaking manner in which they have dealt with the subject. As a previous speaker has remarked, the thanks of the industry are due to the Corporation of Birmingham for providing facilities for research of a highly technical nature, and for allowing their staff to give such full and lucid details of the work done and of the results obtained. In my own case, a very large proportion of the gas manufactured is distributed to heating arrangements of various types, and my experience leads me to express very strongly the opinion that, if the gas industry means to capture the large field of industrial heating, too much stress cannot be laid on the necessity of supplying a gas which has a constant density, a constant calorific value, and a constant comburivity, or ratio of air required for complete combustion. Only thus can the necessity for constant regulation of burners be avoided and economical working maintained.

I can most heartily endorse the remarks made by Messrs. Smith and Walter on this head. I can also endorse, from my own experience, their remarks on furnace construction in general, particularly on the amount of combustion space required, on the benefits of rough-casting the interior of the combustion chambers, and on the advantages of a high gas velocity in increasing the rate of heat transfer. I am not able, however, to agree with the authors' views on gas injectors. In their paper they give the usual text-book investigation into the adiabatic flow of a gas from a nozzle, and arrive at the result that the maximum mass rate of flow occurs when the ratio of the pressures at the inlet and outlet of the jet is $\frac{1}{0{\cdot}54}$.

Throughout the calculation, the assumption is made that the inlet pressure p_0 is constant. Under these conditions, the maximum rate-flow exists when $p_1 = 0{\cdot}54 p_0$. The reverse, however, is not the case—*i.e.*, that if p_1 is constant, the maximum mass-rate flow does not occur when p_0 is $\frac{1}{0{\cdot}54} p_1$ but increases continuously with p_0. The authors have made this erroneous assumption, and consequently state that, when discharging into the atmosphere, the maximum rate of flow occurs when p_0 is 25-inch gauge pressure of mercury, the limiting velocity being 1450 feet per second. Anyone who takes the trouble to work out the formulæ will find that this discharge and velocity is exceeded if the pressure p_0 is increased. Experiments on jets show that the formula is only true so long as the limiting condition is not passed. However much the pressure of the atmosphere into which the jet discharges is reduced, the pressure in the jet never falls below the limiting value of p_1, and consequently for any given value of p_0 the maximum rate of flow obtains for any value of p_1 less than $p_0 \left(\frac{2}{\gamma + 1}\right)^{\frac{\gamma}{\gamma - 1}}$

The whole of the argument advanced by the authors depends on the accuracy of the original assumptions. These may be summed up as follows:

(1) *Air Supply to Burner is at Rest.*—In no injector which has come under my notice is this condition fulfilled—in fact, for the assumption to be in any way justifiable argues a bad design of injector throat. It is possible to obtain a velocity of the order of 400 feet per second in the air before mixing; and I shall show later that the higher this velocity the more efficient the injection.

(2) *Pressure of Gas at the Outlet of the Gas-Jet is Atmospheric.*—Here again this condition argues a bad design of jet and injector throat. I have found it possible to construct a burner where the pressure in the injector throat is 8 inches of mercury less than atmospheric. The lower the pressure here, the greater the injector efficiency.

(3) *Gas Flow is Adiabatic.*—When we remember that for this condition to hold the temperature of the gas in the injector throat would, under the conditions of pressure suggested in the paper, be 45° C. less than that of the gas in the supply-tube, and that all the energy lost in friction must of necessity be returned to the gas as heat, also that the gas is in intimate contact with a metal jet under ideal conditions for a rapid heat transfer, the assumption hardly seems justifiable. My own experiments seem to suggest that the flow is nearly isothermal—in fact, in one jet with which I experimented, after the limiting condition was reached the ratio of $\frac{p_0}{p_1}$ was found to be 1·59 and not 1·85, as would have been the case were the flow purely adiabatic.

(4) *Friction is Negligible.*—This, as is later stated in the paper, is certainly not the case. For brass jets and cones, the friction is considerable, often amounting to 10 or 15 per cent. of the energy of the gas. The usual "hydrostatic" formula will give results agreeing fairly closely with experiments, if a suitable coefficient of friction is chosen. For polished brass cones, the value is about $0{\cdot}002\left(1 + \frac{1}{12d}\right)$, and agrees fairly well with that usually accepted for straight pipes.

As an illustration of the increased efficiency due to having the air in rapid motion before injection takes place, I should like to place before the Institution the following figures: Taking the specific gravity of the gas as ·48, and assuming that we are desiring to inject 5·3 volumes of air per volume of gas, we have—

	Authors' Assumptions Taken.	Air having Initial Velocity of 300 Feet per Second.
Momentum of gas	$0{\cdot}48 \times 1450 = 696{\cdot}0$	$0{\cdot}48 \times 1450 = 696{\cdot}0$
Momentum of air	$5{\cdot}3 \times 0 = 0{\cdot}0$	$5{\cdot}3 \times 300 = 1590{\cdot}0$
Momentum of mixture	696·0	2286·0
Velocity of mixture	$\frac{696}{5{\cdot}3 + 0{\cdot}48} = 120{\cdot}4$ ft. per sec.	$\frac{2286}{5{\cdot}3 + 0{\cdot}48} = 395{\cdot}6$ ft. per sec.
Energy of mixture	$= \frac{1}{2} M.v^2 = 5{\cdot}78 \frac{120{\cdot}4^2}{2} = 41{,}899$	$5{\cdot}78 \times \frac{395{\cdot}6^2}{2} = 452{,}171$
Subtract original energy in air	0	$5{\cdot}3 \times \frac{300^2}{2}$ 238,500
Net energy added by gas	41,899	214,671
Efficiency of injector	$\frac{41{,}899}{\text{Original energy of gas}} = \frac{41{,}899}{0{\cdot}48 \times \frac{1450^2}{2}} = \frac{41{,}899}{504{,}700} = 8{\cdot}3$ per cent.	$\frac{214{,}671}{\text{Original energy of gas}} = \frac{214{,}671}{0{\cdot}48 \times \frac{1450^2}{2}} = \frac{214{,}671}{504{,}700} = 42{\cdot}53$ per cent.
Final velocity after bringing back to atmospheric pressure and allowing for 50 per cent. of the energy to be wasted in friction in second case	120·4 ft. per sec.	214,671 less 50 p. ct. 107,335 = 107,335 available [energy. Velocity $= \sqrt{\frac{2 \times 107{,}335}{5{\cdot}78}}$ = 287 ft. per sec.

The application of mathematics to such problems as these should always be made with caution as to the assumptions made; and I trust that the authors will accept this criticism in the spirit in which it is proffered—my only object being to indicate some points in which mathematics may fail to represent actual working conditions.

CREATING AN OUTDOOR STAFF.

By F. W. GOODENOUGH, of London.

The title which I have given to this paper is intended to imply more than the selection and training of outdoor representatives for a gas undertaking. It is intended to cover the whole process of education involved in the creation of a body of workmen and officers thoroughly competent to carry on all the varieties of work and service entailed in the supply of gas to the public on modern lines.

The subject with which it is proposed to deal includes, first, the training of lads to be skilled and intelligent mechanics from their school days onwards. This necessarily leads to a consideration of the suitability of present-day methods of elementary education as a preparation for the life of an artizan, and of the desirability of constant, organized consultation and co-operation between employers of labour and educational authorities. The question of improving the knowledge and skill of grown workmen who have entered, or may enter, the service of a gas undertaking without having been trained on scientific lines, also falls within the scope of the paper.

The subject further includes the training of lads to be men possessing commercial ability and acumen, as well as sound knowledge of the technics of the industry; and the development of greater commercial and technical knowledge among those already on the staff. The matter outlined is one of great and growing importance to the industry, and worthy of careful consideration by the members of this Institution at a meeting which comes at the end of fifty years of useful work, and at the beginning of a new century of public service, which, while it opens full of promise and hope, yet calls for fresh enterprise and progressive methods if the promise is to be fulfilled to the full extent of our desires.

My excuse for undertaking so large and important a task on such an occasion must be, first, that it is a subject in which I take a deep interest, and of which I have some first-hand knowledge; and, second, that such knowledge and experience regarding it as I possess have been gained under the inspiration and direction of Sir Corbet Woodall, whose keen practical interest in the training and education of the rising generation in the gas industry is well-known, both in this country and on the Continent. It therefore seemed not inappropriate that I should endeavour to give to the Institution, at the Jubilee meeting over which Sir Corbet would be presiding, an account of the work with which I have been connected in the direction of creating an efficient staff for the service side of the business.

The Need of Educational Reform.

The whole question of education—elementary, secondary, and advanced—is very much in the air at the present time, and the much-needed reforms in the whole scheme of education in this country, which we are promised in the near future, are eagerly awaited by those who realize at once the inadequacy and inaptitude of our present system, and the importance to the national welfare of sufficient and appropriate education for all classes. What is so much needed for the whole body of the nation is a system of education which shall have (in Ruskin's words) "a definite relation to the work each man has to do, and the substance of which he is made," and shall have for its aim "the leading of human souls to what is best, and making what is best out of them." That is, briefly, what those are seeking who believe that the training which makes men most serviceable to others makes them happiest in themselves, and that the confounding of erudition with education is a fundamental error. The battle of the truly useful, as opposed to the purely ornamental, in education has been waged for many years; and though the advocates of the ornamental have had to yield ground and are fighting a rear-guard action all the time, the struggle is prolonged and arduous, and victory is still far from won for the cause of common-sense.

Education is even now far too generally regarded as a process of filling-in—of cramming—instead of (as its root meaning implies) one of "drawing-out," one of mental development and growth. If one turns to what Herbert Spencer wrote on the subject nearly forty years ago, it is to realize that we have not moved either very fast or very far in the interval. As in the matter of clothes, so in that of education, Spencer pointed out, the tendency is to regard ornament before fitness—"the function is still in great measure subordinated to the appearance," and the "knowledge which conduces to personal well-being has been postponed to that which wins applause. . . . The remark is trite that, in his shop, or in his office, in managing his estate or his family, in playing his part as director of a bank or a railway, the boy is very little aided by the knowledge he took so many years to acquire—so little, that generally the greater part of it drops out of his memory."

The Weakness of Our Elementary Schools.

And what was, and still to too great an extent is, true in regard to our University system of education, was and still is true in no small degree of the education in our elementary schools. If anyone doubts this, let him take a dozen boys who passed out of school from the top standard a year ago, and who have had no further education in the meantime—who have been errand boys or van boys or even office boys—and see how much they retain of what they were taught at school, and test their mental development generally. Speaking with some knowledge of the subject, I say emphatically that our present system of elementary education is a lamentable failure, judged by its power of fitting boys for the business of life—both for living aright and for earning a livelihood in a worthy manner.

It is very satisfactory to note, from the recent utterances of Ministers, that steps are contemplated in the near future to secure continuative education for a larger proportion of the boys who leave our elementary schools at 12 to 14 years of age. But one cannot help feeling that if reform is only to begin at that stage it will leave untouched the widest question of all—that of making the training which the boys receive in the elementary schools such as will better fit them to become useful, self-respecting, and happy members of the social body. That, however, is a subject that is somewhat outside the range of this paper, which has to deal with continuative rather than elementary education. But I may, perhaps, be pardoned the reference, because, if the foundations (of elementary education) be faulty, the superstructure (of continuative education) must necessarily be more difficult to build.

Pending the reconstruction of the foundations, however, those who are struggling with the upper floors must do the best they can, and hope for assistance in the work from the legislature at no distant date.

Example and Experiment.

But in educational matters, as in those affecting the relations of capital and labour, I hold very strongly that it is for those who realize the need for change, and who have it in their power to do anything to bring about improvement without waiting for legislation, to take the initiative, and by their example and experiment show what can and what should be done. Legislation, after all, if it is to be of any practical value, can only follow upon, and not precede, experiment in such a matter; and this paper has been written in the hope that some account of what has already been accomplished in a small way in the direction of continuative education, organized to the end of fitting boys and men for definite vocations, and of helping them to play a useful part in life, and thereby to acquire a greater share of happiness, may lead to further experiment on a larger scale, to the more general adoption of practical methods of education, and to at least a partial solution of the problem of "blind alley" employments which has rightly engaged considerable attention in recent times. I will therefore now leave the fascinating subject of education in general, and turn to the question of education in relation to the gas industry in particular, and that only in one of its branches.

Education in the Gas Industry.

The need for more extended and better organized technical education was widely recognized in the engineering side of the gas industry, as in other branches of the engineering and manufacturing world, a good many years ago; and, without entering upon the thorny path of political contro-

versy, one may perhaps express regret that during the past ten years the hope of being assisted to fight foreign competition by legislative means has led to the vital importance of increasing our standard of technical education being somewhat overlooked by the captains of industry. But the subject with which I have specially to deal is not that of technical education in the generally accepted meaning of the term, as applying to constructional work and manufacturing processes, but rather that of a particular scheme of technico-commercial education—the specialized training of individuals in the theory, the practice, and the general knowledge required to fit them for the pursuit of a specific trade or calling—to wit, that of the "Public Service" side of gas supply.

The importance of this public service side of gas supply, as I have called it, and in the sense in which I use the term, has only been generally recognized for comparatively a few years—indeed, its very existence (in any true sense of the words "public service"), has not yet been of many years' span. It would, moreover, be to take an altogether too rosy view of the facts to say that its true importance is even yet recognized by the general body of those responsible for the administration of the gas undertakings of the country. The fact that to attain and maintain the maximum of prosperity in the business of gas supply it is not merely necessary to supply such quantity of gas of statutory quality and pressure as the public may demand, but also to take every possible means to ensure, first, that the public get the very best possible value out of the gas they buy, and, second, that they buy as much gas as they can use with profit to themselves, is not yet universally recognized.

For a good many years now, however, this truth has been realized by a great many enlightened gas directors and committee men, with the result that an ever-increasing number of undertakings have taken upon themselves the task of advising and educating the public upon all matters relating to the use of gas, and have undertaken to supply, fix, and maintain all kinds of gas appliances for lighting, heating, cooking, hot-water supply, power, and industrial purposes. This development of the public service side of the industry has necessarily led to the creation of two urgent demands.

New Methods Create New Demands.

The one is for a higher degree of technical knowledge and commercial aptitude among the staff who have to deal with the public than that staff possessed in the old days of "take-it-or-leave-it-but-pay-in-advance-for-it-if-you-want-it." I would point out that I refer here not only to the staff who deal with the public on the district, but also to those who deal with them in the office by interview or correspondence. This is a point all too often overlooked, with the consequence that the indoor staff, for want of knowledge or training in matters of policy and true salesmanship, sometimes undo half the good accomplished by the outdoor representatives of an undertaking. The second urgent demand is for a higher degree of technical knowledge and of mechanical skill among the workmen who have to execute works of installation and maintenance than was necessary before such work was undertaken.

How the Demands Can be Met.

The purpose of this paper is to give some account of the work that has been done in the direction of meeting these demands in the case of the Company which I have the honour to serve, in the hope that it may provide some suggestions as to what could be done elsewhere in the country to develop the educational organization of the industry. The moment is opportune for suggestions and discussion, as the valuable work of the Committee who have been considering the question of the training of gas-fitters is being brought to a head, and will, there is every reason to hope, be productive of good result in the near future.

The public service side of gas supply in the district of the Gaslight and Coke Company was separated from the purely distribution side some ten years ago. The work of installation and maintenance of appliances in consumers' premises was then by degrees taken in hand, and the task of advising consumers as to what apparatus to use, and how to use it, was entered upon. This immediately made evident the need for more fully instructing staff and men in the subjects on which they were required to advise the public, and the work which they were called upon to do for them. Periodical lectures by senior members of the staff were first of all adopted as a means of instruction and an opportunity for discussion upon various subjects. These proved of so much interest and value that in 1906 the Directors decided upon a more comprehensive scheme of scientific and technical instruction, in a properly-equipped lecture hall, for the benefit of the staff of what now bears the title of the Gas Sales Department.

A Staff Instruction Scheme.

The scheme was entrusted for carrying out to a qualified gas expert (Mr. W. H. Y. Webber) as "Lecturer," the Directors being of opinion that the occasion called for the best available teaching. Started as an experiment, the results, taken in conjunction with the annual examinations which were embodied in the scheme in the following year, have proved so satisfactory that the system has become an integral factor in the working of the department, both for the continuous improvement of the practical efficiency of the staff and workmen, and as a guide to the distinguishing and recognition of merit.

The scheme of instruction was divided into two sections, denominated respectively as "lecture courses" and "demonstrations." The lecture courses were designed to meet the requirements of the department's staff officers, but to those students have been added, from time to time and as suitable cases have presented themselves, a selection of the most promising show-room attendants, leading fitters, and older apprentices. There is no formal syllabus, the Lecturer having a free hand to teach whatever technical matter he, in consultation with the head of the department, deems most expedient. This decision is governed by contemporary requirements arising out of the incessant advance in the technics of the subject, and also by the existence of weaknesses betrayed by examinations.

The demonstrations were planned to meet the needs of the fitters, assistant fitters, maintenance men, and junior apprentices, though there is, in effect, no hard-and-fast classification of those who attend either the "lectures" or the "demonstrations." Any approved employee of the department, clerical or mechanical, is at liberty and is encouraged to apply for permission to attend either or both of the courses. The subject-matters of the "demonstrations," as the term implies, are actual pieces of gas apparatus, such as the men handle in the course of their every-day work. The principles upon which the design, construction, and use of the appliances are based are explained and demonstrated, and the proper fixing, testing, and operating of the appliances are shown.

The lecture courses run from October to early December, and from January to early March. Lectures are given on four nights a week; each student attending once each week. The demonstrations go on from April to early June, and from July to early September—no instruction (either lectures or demonstrations) being carried on during the quarterly meter-taking periods. Attendance at the demonstrations is obligatory upon those who have not previously been through a course; and the men are given tea and their travelling expenses, if any. Demonstrations are given on four nights a week; and each man attends once a week for three consecutive weeks each summer.

By these means, a large number of both officers and men who had been for some years in the Company's service when the scheme of instruction started, and others who have entered since with but imperfect knowledge of modern practice in gas supply, have been enabled to raise their efficiency to a much higher level than they had previously attained.

Examinations.

In April of each year, an examination is held for both sections of students, though any student who desires can take the higher (or "A") grade paper. Copies of the papers set this year are given in Appendix A. All employees of the department are free to sit for these examinations as often as they like. The majority naturally take the lower (or "B") grade paper first; but many proceed to the higher stage straight away. The lower examination is designed to test the fitness of the aspirants for promotion to staff or superior non-staff appointments; the higher is for those seeking promotion to superior staff appointments. The Directors give substantial money awards to the most deserving candidates in both examinations, and certificates of relative merit—"Very Highly Commended," "Highly Commended," and "Commended"—to all who obtain certain percentages of the highest possible marks.

The lecturer is also the examiner. This plan works

extremely well, and is most helpful to both parties. By the answers to the questions set, the lecturer is able to perceive how the future instruction should be directed. The examination, therefore, becomes a basis for the teaching, as well as a test for it and for the candidates. Moreover, as the same candidates, or certain of them, come up repeatedly, their true capability is better shown than it would be in a single examination, when for any reason they might fail to do themselves justice.

Mr. Webber, in a report upon the working of the scheme, remarks that its beneficial effects go far beyond the regular teaching. "The men," he says, "perceive the advantage and acquire the habit of private study. They ask the lecturer's advice on the choice of books, and apply to him for assistance in their difficulties. They are led to realize that careers are open to talents and character; and they know that no man need be passed over in the flow of promotion except by his own fault. Common attendance for the reception of instruction, moreover, tends to soften individual asperities, and encourages men to 'look up' beyond the person of the instructor to the good will of the chief officers and the Directors."

Incidentally to the lecture and demonstration courses, occasional lectures and demonstrations dealing with special subjects are given by experts in a larger hall, where the whole of the staff can be brought together.

Encouragement to Students.

Every encouragement is, it may be added, given to employees to attend classes in "Gas Supply" held at Polytechnics or elsewhere in London, and to sit for the City and Guilds examinations in this subject, which includes the purely distribution as well as the installation and utilization sides of the problem. On production of satisfactory evidence that a student has made not less than 75 per cent. of possible attendances at "Gas Supply" classes, the Company refund the whole of the fees to the student. To those who obtain City and Guilds certificates, the Directors give, in addition, books to the value of from 10s. 6d. (in the case of a second-class Ordinary certificate) to £2 2s. (in the case of first-class Honours.)

In regard to the classes in "Gas Supply" above referred to, the Company have co-operated with the educational authorities as fully as possible by giving members of their staff permission to take the position of instructors; and such positions are held at present by eight of the Company's servants. This has the advantage of securing uniformity of technical practice among the private fitters of the district as well as among the gas-fitters and outdoor officers throughout the Company's service, and of ensuring that the work of instruction is in the hands of properly qualified men. This is a real service to the educational authorities, to the public, and to the industry, which the gas undertakings throughout the country should, as I have no doubt many do, seek to render at every possible opportunity.

Training in Salesmanship.

The scheme of instruction so far outlined only deals with the technical side of the public service work of a Gas Sales Department. But it is, of course, by no means sufficient for the officers of such a department to possess accurate technical knowledge of gas appliances, their construction, installation, and application. They must know how to interest the public in these appliances; they must have the ability to convince consumers that it is to their advantage to extend their usage of gas; they must have learned to study every consumer's requirements and circumstances—whether domestic, commercial, or industrial—so as to be able to recommend such gas appliances, and such appliances only, as will give that consumer efficient and economical service; they must be capable of dealing with complaints so that they can be remedied to the consumer's satisfaction, and in such a way that the consumer's confidence is regained; they must have learned to analyze complaints so as to prevent their recurrence; they must have received training in the art of correspondence; and they must have received instruction in many other details that go to the equipment of an outdoor representative who is capable of rendering true service, alike to his employer and to the public.

To these ends, our officers and men are encouraged and assisted to enter courses of instruction in the essential principles of salesmanship; addresses are from time to time given to the staff by the head of the department or some of his chief assistants; suitable books and periodicals are circulated among the staff; and a debating club, for the discussion of the questions outlined above and any other matters concerning the efficiency of our service to the public, has been established. The effect of these efforts is to be found in an attitude of steadily growing confidence and friendliness on the part of the public towards the Company, a constant seeking of assistance and advice in all matters relating to the use of gas, and a substantial increase in our output.

Gas Undertakings as Gas-Fitters.

The rapid and continuous growth in the demand by the public that their gas supplier shall also act as their gas-fitter has led every progressive gas manager in the country to look around with anxiety for an adequate supply of competent gas-fitters, both for present and for possible future requirements. The importance of taking some practical step to meet a growing difficulty impressed itself upon the Governor of my Company (our President to-day) several years ago, with the result that in 1908 a scheme for the practical training of lads, taken direct from school, in the art and craft of gas-fitting, was adopted by the Directors.

A Scheme of Apprenticeship.

This scheme was based upon co-operation with the London County Council, who, from the commencement, have taken a very keen and helpful interest in what is called our system of apprenticeships, though, as a matter of fact, the lads are not "apprenticed" to the Company in the generally-accepted meaning of the word. From the form of application filled in on behalf of every candidate for employment under the scheme (a copy of which is to be found in Appendix B) it will be seen that the parent or guardian of the lad agrees to the terms of employment, and gives certain undertakings in regard to him; but no formal indentures are entered into, and the Company reserve to themselves the right to discharge any lad they may find unsatisfactory.

It may be mentioned here that of 119 lads who have entered our service under the scheme, only 13 have been discharged for unsatisfactory work or conduct. Five others have left of their own accord to seek employment elsewhere, one has died, and 100 remain with us under training. The Company pay the lads from the commencement. During his first year, every lad receives 2s. 6d. per week. In the second year the pay varies according to capabilities and conduct, with a maximum of 10s. per week. In the third and fourth years, the maximum is 18s. per week; in the fifth, 20s.; and in the sixth 22s. 6d. It may be added that the scheme is practically self-supporting.

For the purpose of this training, the Company erected workshops at Horseferry Road, fitted with all necessary plant and apparatus. A schedule of the plant installed, together with a plan of the shops, will be found in Appendix C.

The Selection of Candidates.

The Company take into their service for training about twelve lads every six months. The selection of the lads is entirely in the hands of the Company, and is made the subject of very careful consideration by the General Manager (Mr. D. Milne Watson, who is very keenly interested in the scheme) and myself. Applications are invited by the London County Council from pupils attending elementary schools in the district, while, in addition, direct applications are made to the Company by the sons or relatives of officers and men in the service. Physical fitness, tested by a medical officer, and mental alertness, so far as can be judged by a personal interview with each candidate, are taken into account in making the selection; while the standard of scholastic attainment required of the lads is that defined as Standard VII. of the elementary schools, combined with aptitude shown in the manual training classes. Standard VII., it may be remarked, must vary greatly in different schools, as it would otherwise be impossible to explain altogether the marked variation subsequently found in the mental capacity of the lads. In regard to this question of mental capacity and development of the lads when they leave the seventh standard, much could be said.

Weakness of Our Elementary Education System.

The Principal of the Westminster Technical Institute (Mr. J. Stuart Ker, B.Sc.), to whom I am indebted for a very interesting report on the subject of our apprenticeship scheme,

as well as for most valuable and willing assistance during the past five years, himself remarks that "it should be—and no doubt is—recognized that the work of our instructors here is rendered more difficult owing to lads coming up badly grounded in the elements of a sound education. But we find this difficulty all through our technical work; and it is not peculiar to the gas-fitter apprentices, who may be taken as average types. Now that much smaller classes are the rule in elementary schools, there should be a general improvement all round." I can only say that I devoutly hope there is good ground for Mr. Stuart Ker's belief; for the need of a general improvement in the elementary education system in this country, as I have previously remarked, makes itself evident every day to every business man who has to employ the product.

When I mention the fact that, out of twenty-six essays recently submitted to me by lads who have for four years been undergoing a course of continuative education carefully designed to improve their English and composition, only two were free from errors of spelling, while many were marred by indifferent grammar, or defective arrangement and paragraphing of matter, I shall be acquitted of speaking with undue harshness of our present system of elementary education.

An Expectation of Improvement.

It is ten years since Sir Philip Magnus, addressing the National Association of Manual Training Teachers, said:

"We have now begun to realize the fact that the acquisition of knowledge is not the sole aim or purpose of a child's school training. It is enough if, in our elementary schools, we can show how knowledge may be sought. . . . Instead of trying to make children *know*, we shall train them to *do*. . . . The central feature in all our schools will be the workroom—the room or shop or laboratory in which children work with their own hands and gain their knowledge by ordinary experimental methods. It will transfigure the entire teaching. . . . More time and thought will be given to reading and writing than those important subjects have hitherto received."

He added much more of pointed wisdom (to be found in that interesting book, "Educational Aims and Efforts") which space forbids my quoting. But, as yet, the much to be desired change foretold by Sir Philip is still mostly in the future. May his optimism soon be justified by events!

But I have digressed from the point at which the lads have been selected, and have now to describe the course of instruction which they undergo. The course, throughout, is a combination of practical and theoretical instruction in gas matters by the Company and of general and specific continuative education by the County Council, the Company giving the apprentices the leave of absence from the shops or district necessary to enable them to attend the Council classes. This is an excellent example of co-operation (somewhat on the half-time principle, of which I am a strong advocate) between a local education authority and an employer.

A Six Years' Course in Gas-Fitting.

To take the practical and theoretical instruction in gas matters first, the following is an outline of the six years' course that has been planned out for the training of the lads in our workshops and on the district.

First Year—First Six Months.—In the workshops every morning from 8 a.m., and two afternoons until 5 p.m. At the London County Council Institute three afternoons in the week.

On entering the shops, the apprentices are first taught the names and uses of tools. A full kit is displayed, and each tool and the methods of using it are described—*e.g.*, how to use the file, cutters, pipeholder, stocks and dies (solid and split); the nature of cast and wrought tools; how to pack the tool bag, &c. The lads are also instructed in their duties and responsibility to the fitters under whom they will later have to work.

On other days, they are sent into the carpenters' shop, where they are taught the names and uses of carpenters' tools; the cutting of joists; and the taking up of floor boards, facia boards, skirtings, &c. Towards the end of the six months a section of tongued, grooved, and plain flooring is operated upon, a leading carpenter instructing in and superintending the work. While in the carpenters' shop, the lads make steps, trestles, tool-chests, and other useful articles for the district and shops.

This continuation of the training in wood-work which commenced when the boys were at their elementary schools (in the excellent manual training classes that are doing much—but not nearly enough—in the direction of making education in those schools of real value) has, in my opinion, a value far in excess of the skill in carpentry which the boys thereby acquire.

Working in wood serves to inculcate habits of exactness in measurement, of consideration before action—"always measure twice before you cut once," was a maxim impressed upon me by a carpenter when I was a small boy, and I have never forgotten it—as well of accuracy and truthfulness in every operation. Such habits, acquired by personal and sometimes painful experience (together with the quality of self-reliance engendered by successful achievement in constructive work), are of great value in after life. That is why I attach great importance to the carpentering work done by our apprentices.

The lads' work in the shops is varied daily. Thus a lad will get a day with the carpenters; one on the use of dies, cutters, files, &c.; one with a tinman; one with a brass finisher; and others in the dipping shed (where gas-fittings are re-lacquered), in the polishing shops, at the forge, and at joint-blowing, pipe-bending, &c.—being put with the various tradesmen first to watch them for a time and afterwards to assist them.

In the actual training shop, instruction is given in the names and sizes of various pipes and fittings—iron, brass, lead, compo., and copper tube—and their uses and methods of fixing; joint-blowing is taught in lead to lead and lead to brass, and the making of saddle-joints and stop ends; the bending of wrought-iron pipe by machine and forge is practised; the lads are made familiar with the gauges of threads (numbers to the inch, &c.); they are taught the cutting and plugging of walls; and the construction and repair of ground-in joints for cups and balls, cocks, swivel-joints, &c.

Brief and simple lectures are also given by the Instructor, who was selected from among the Company's foremen for his wide, practical experience, his sound technical knowledge, and his capacity for imparting that knowledge to others. These lectures deal with the manufacture and component parts of coal and carburetted water gas; the evolution and flow of gas from the retort to the consumer's meter; the construction of meters and their reading and fixing; the reading of pressure gauges; and the construction and use of luminous and atmospheric burners, gas-fires, cookers, and water heaters.

First Year—Second Six Months.—After this preliminary training in the workshops, the lads are sent out on the district to put their knowledge to practical use with the fitters, acting as assistants to them, and getting a varied experience in dealing with consumers' complaints and defects, and in running supplies for fittings, fires, cookers, &c. During this period, the lads continue to attend the London County Council Institute on three afternoons a week.

Second Year—First Six Months.—At the commencement of the second year, the lads again return to the workshops for more advanced tuition. They first work with the smiths in order to learn the tempering and drawing-out of chisels, drills, &c.; the repair of tongs and other tools; the making of clips and similar smiths' work.

They then are put with the tinmen to work on sheet iron, zinc, and copper, making flue-pipes, elbows, canopies, and hoods for cookers; and repairing all types of incandescent lamps and fittings.

In the brass shop, they next learn turning at the lathe and brazing, and assist with the conversion of electric to gas fittings, and of water-slide to fixed chandeliers.

In the dipping, polishing, and lacquering shops, they obtain a good knowledge of the processes through which a fitting has to go when being re-bronzed, re-silvered, or re-polished.

They are also taught the bending of large lead pipes for meter fixing; the making of 1½-inch and 2-inch joints by torch, rushes, and blow lamps; of small meter connections for use on the district; and of illumination devices, such as crowns, stars, and letters, in wrought iron and copper tube. They learn the drilling, tapping, and punching of holes; the making of bracket irons with scrolls for outside lamps; and the fixing of a gas-engine—including making-up the bed in concrete, fitting and fixing all pipes for gas, water, and exhaust, as well as the starting, overhauling, and repairing, and leaving the engine in running order.

A week is then spent in the fields adjoining the shops on trench work. A trench 40 feet long is dug out and four 4-inch pipes are laid by the lads, who are taught the use of run lead and lead-wool joints, and the work of yarning-and setting-up joints. Holes are then drilled and tapped, gas is connected to the main, and the main tested; bags are inserted and a section of the main cut-out and teed-off. All points are explained as the work proceeds. Afterwards, the pipes are taken out and apart, and the trench filled in.

A visit to one of the gas-works is also made to enable the lads to see the various processes entailed in the manufacture of gas from start to finish.

During this second period in the workshops the Instructor's lectures deal with the theory and efficiency of gas engines and their fixing; hot-water installations and heaters—their construction, fixing, and the laws of hot-water circulation; the carcassing of houses, with special reference to the sizes of pipe to use; the various types of governors; the influence of pressure on all appliances; stove defects and remedies; high-pressure installations, compressors, and lamps, &c.

Each lad is also given the time to make a specimen of his work to leave behind in the workshop (the choice being left to him), and the walls are well adorned with such specimens.

Second Year—Second Six Months.—At the end of the third six months, which completes their training in the Westminster workshops, the lads again return to the district, where their work is varied as much as possible from that done during their first period with the fitters, part of the time being spent in assisting installation fitters on all classes of carcassing and fitting work, and part in meter-reading. Their school work for the second year is altered, the attendance at school being for one whole day instead of three half days per week.

Third Year—First Six Months.—The apprentices continue on the district, engaged on work similar to that done in the previous period, variations being made from time to time to secure all-round experience for each lad.

Third Year—Second Six Months.—They are then transferred to the meter-testing and stove-repairing shops at Fulham or Haggerston, to obtain a thorough knowledge of the construction of meters and stoves.

In the meter-testing department, the apprentices are trained in the first place to read an index correctly, and when they have mastered this, they are taken on with the meter-provers to follow through the process of meter sounding and testing.

The causes which affect the accuracy of a meter are explained to them, and such cases as the unsteady working of a meter causing the lights of a house to oscillate are fully demonstrated. The danger of a leaky index or unsound case is also explained, and the necessity for

accuracy in reading the holder scale in computing the percentage of error.

When dealing with automatic meters, the differences in the methods adopted by the various makers for working the attachment are pointed out; and it is made clear that this useful adjunct to the meter is purely mechanical and cannot affect the registration of the meter proper as stamped by the London County Council.

In the stove-repairing shops the apprentices work with the men, taking to pieces and re-assembling stoves, fires, radiators, condensers, boilers, and water-heaters. By this means, they very soon get a good insight into general construction, renewals, repairs, testing and adjustments, their attention being specially drawn to the points requiring most care in respect of each type of apparatus.

At the commencement of the third year, the London County Council Institute tuition is altered to two evenings per week instead of one whole day.

Fourth Year—First Six Months.—The Mantle Maintenance Department now takes the apprentices in hand, and they are sent out with the maintenance men to obtain a knowledge of the methods adopted in the maintenance on consumers' premises of all types of incandescent burners and lamps in general use. They have, of course, previously become acquainted in the workshops with the various parts of burners, and they have now rather to acquire a knowledge of methods for avoiding the breakage of mantles, and the routine of maintaining and cleaning burners and lamps of all descriptions, whether low or high pressure.

This course of tuition occupies six weeks, after which the apprentices are put to a six weeks' course of joint-wiping, which it is so necessary that fitters should now be proficient in, owing to the great increase in the number of water-heating appliances now in use in the fixing of which wiped-joints are required. This knowledge is also useful in the event of a fitter accidentally driving a chisel or hook through a buried lead water-pipe, as he is then able to repair the joint at once, instead of causing annoyance and inconvenience to the consumer in waiting for a plumber (formerly a source of many complaints).

Three months are now spent with the stove maintenance fitters, assisting them in dealing with all kinds of defects in heating stoves, cookers, fires, radiators, water heaters, &c., and with down-draught and similar troubles. Here the knowledge obtained in the stove repairing shops is of great assistance to the apprentices in taking apparatus apart, remedying the cause of defect, and in fixing new parts and burners.

Fourth Year—Second Six Months.—During the next six months some of the lads are engaged in the show-rooms, to get a salesman's knowledge of every appliance for the use of gas, and to learn how to deal and converse with consumers. The most intelligent and advanced lads are selected for this duty, while the remainder are put with the foremen of the district to act as clerks to them and get a knowledge of office routine in dealing with complaints and repairs.

Fifth Year.—The course of training for apprentices was originally planned for only four years, but it has been found desirable to extend this for at least another two, and the first batch of lads have now started on their fifth year of training. Throughout this period they will be on the district acting as fitters' mates, gaining further practical experience in connection with ordinary and automatic complaints, including night duty; meter changing, index-taking and queries; high-pressure installations for parade lighting and their maintenance; the running of compressing stations and the maintenance of public lamps; and all other branches of district work.

Sixth Year.—During the first three months the apprentices will be tried as fitters, dealing with automatic complaints and repairs on their own responsibility. During the second three months, they will be tried as stove maintenance fitters, working alone. During the third three months, they will be employed in the office, learning the office routine; and during the last three months they will be employed on the district in learning estimating work—how to set out a job, measure up, and arrange all the details for an installation.

The work planned for this last year may have to be spread over a longer period. By the time it arrives, all that the best lads will require will be that experience which alone can make a man either a qualified fitter or a staff officer, and without which the best training, both theoretical and practical, is of little avail. It will then be time to divide up the lads into those who are fitted to be skilled artizans alone and those who are qualified, by intellect, character, and ability, to become staff representatives of a gas undertaking. I am happy to say, from my knowledge of them, that we have 100 lads who will make either the one or the other, and that quite a number will come into the second class. That they will have had every opportunity of qualifying themselves for such superior employment will be evident from the account I have given of their workshop and district training, and that which I now have to give of the tuition they will have received at the hands of the London County Council at the Westminster Technical Institute. For this purpose I cannot do better than quote from the "Memorandum" which the Principal and his staff have prepared for me, in connection with this paper, on the work done at that Institute.

TRAINING OF GAS-FITTER APPRENTICES AT THE WESTMINSTER TECHNICAL INSTITUTE.

Principal's Note.

The courses of instruction are set out by the various teachers with their observations thereon in the attached reports, and I need not enlarge on these, as the teachers are much more intimately in contact with the lads than I am.

Naturally, the courses were experimental at first, and they are gradually being improved as experience is gained with the various and varying groups of lads.

In passing, I should like to say that it is a new experience for me, and a welcome one, for an industrial company to insist on instruction in English right through the full period of training; and I know such instruction is needed.

Summarized, the courses of instruction are:

First Year.—Attendance for three afternoons (9 hours) each week, for about forty weeks a year, at technical calculations, drawing, and English.

Second Year.—Attendance for one whole day, of 6½ hours, each week, for about forty weeks a year, at technical calculations, elementary physics, and English.

Third and Fourth Years.—Attendance for two evenings a week (= 4½ hours) at gas supply and English. Also for a short course in joint-wiping.

Fifth and Sixth Years.—Attendance for two evenings a week for more advanced work in gas supply and English.

By a system of weekly, monthly, and terminal reports, the Company are kept in close touch with the educational work, and can ensure punctual and regular attendance.

During the whole course the teachers recognize that it is as important to develop common sense or intelligence as to impart a knowledge of arithmetic, English, or drawing.

Habits of attention, neatness, and discipline are gradually acquired, and the ability "to learn" is slowly but surely increased.

Note-books are kept, and the boys are constantly advised to refer to them when in trouble with a problem, before giving it up as hopeless and referring to the teacher.

Strict application to work is enforced without harshness, and the boys gradually get to see that, even if they dislike school, a very good plan to pass the time is to work hard.

A sound general education is given, apart from any application of knowledge to their practical work, although, of course, whenever possible, the application of some particular branch of their school work to the gas industry is pointed out.

Opportunities are never lost by the teacher of making some reference, however slight, to topical questions likely to interest boys, such as the boat race, bus and tram competition, the weather, barometer, flying, &c., &c., and problems are set having some connection with these things. For example, when the bus *v.* tram question loomed large, the boys were given bus route maps of London, and calculated the time taken to go from one part to another, allowing for stops, the distances being scaled off by dividers. Another day, a Great Western time-table would be given them to pick out a train from London to Fishguard, time taken, time of arrival in Ireland, length of journey, sea passage, &c., &c.

Before the boys have been at school very long, they see quite clearly that any ideas they may have had of "knowing enough at 14" were quite erroneous. They are encouraged to think and believe that knowledge itself makes them superior to people without that knowledge. Any slackness, natural to boys, is practically neutralized by the method of giving marks for work done each day in class, these marks, in addition to helping to swell their term examination marks, being forwarded to the Company every month with the reports on conduct, progress, &c.

Syllabus of Training in Mathematics, Drawing, Mechanics, and Physics.

First Six Months.

Technical Calculations.—A test is given as soon as the boys start at the Institute; and it is found as a rule that they have little or no knowledge of algebra and mensuration.

Their arithmetic is fair on the average, but not very "sound." The course starts with fractions and decimals, leading on to ratio proportion—percentages—square root—metric system—contracted methods.

Algebra is taught from the beginning, and is continued to simple and simultaneous equations. A great many "problems" are worked, as they have a good "sharpening" effect mentally.

Mensuration from the beginning is kept elementary and practical. Examples are given on the plan of the playground, and of various rooms of the Institute (drawn by the boys from their own measurements). Areas are calculated—costs of paving, &c., are worked out.

Technical Drawing.—The course starts with model drawing—or sketching—from objects such as chairs, stools, ladders, trestles, cupboards, &c.

Geometry.—Simple and practical. Use of scales of all kinds. Construction of various figures. Measurement of areas and angles. Scale drawings of simple fittings, bolts, nuts, elbows, tees, bends, spanners. These scale drawings are made from sketches given on the board by the teacher, who actually draws from the fitting in front of the class, with explanations of the different views and sections.

Great attention is paid to neatness and style. Tracing is started near the end of the first six months.

Second Six Months.

Technical Calculations.—The work of the first six months is constantly revised, and is continued to a more advanced stage. Squared paper work occupies a fair amount of time, all kinds of data being plotted. Logarithms are used for all kinds of practical questions, especially those that show their usefulness to gas industry calculations. Mensuration is made more advanced, volumes and weights of pipes and tanks being calculated. "Supply" calculations are worked by means of logarithms, diameters, weights, costs, &c., being calculated from a town plan.

Technical Drawing.—The apprentices in this course are taught to make scale drawings from dimensioned sketches (of various fittings) made by themselves. The difficult art of making sectional drawings is practised continually. Tracing is done and blue prints are taken. The geometry given is much more advanced and practical—including the geometry of plate work and construction of models of pipes, joints, hoods, cowls, &c., &c. The apprentices are taught measurement of areas by

Simpson's rule—co-ordinate rule—also pictorial and isometric methods of drawing objects.

Third Six Months.

The greater part of this course is devoted to mechanics. The afternoons are spent in the mechanical laboratory on simple experiments illustrating the various laws of mechanics. The morning is occupied with a lecture on mechanics, and frequent opportunities are given for revising and increasing the knowledge of mathematics and drawing gained during the first twelve months' course. The apprentices are made familiar with such terms as specific gravity, centre of gravity, &c., by actual experiment. Experiments are made with levers, beams, inclined planes, pulleys, &c.

Fourth Six Months.

The time is spent in this course on physics, mainly light and heat. The time table is similar to that of the third six months. The afternoon is given up to simple experiments illustrating the laws of heat and light—experiments on specific heat, mixing of substances at different temperatures, laws of reflection, refraction, &c. A lecture is given in the morning on some part of physics; and the work of the previous three periods is constantly revised.

TEXT BOOKS, INSTRUMENTS, &C., SUPPLIED TO THE APPRENTICES.

First and Second Six Months.

Pencil	*Drawing board*
Pen	*T-Square*
Rubber	*Pencil sharpener*
Two set squares	*Cracknell's Practical Mathematics*
Two scales	*Morris and Husband's Geometry*
One ruler	*Hall and Stevens' Arithmetic*
One notebook	*Practical Engineer's Pocket Book*

Third and Fourth Six Months.

All the above used, and in addition apparatus necessary for practical instruction in Mechanics and General Physics.

SYLLABUS OF WORK IN ENGLISH.

First Year.

Exercises in spelling. Exercises in punctuation (with rules and general principles). Correction of common mistakes in conversation and writing. Arrangement of words in a sentence.

Exercises in Composition:—
Easy essays and letter writing on subjects connected with their work—*e.g.*, "How I came to be an Apprentice"; "The Work of a Day in Shop."

Reading practice:—
A play of Shakespeare read in class—*e.g.*, 1912-13, "Twelfth Night." Pitman's "Commercial Reader."

Books used:—
Arnold's Composition (E. J. Kenny).
Modern dictionary.
"Shakespeare for Schools" (Twelve Plays).
Pitman's "Commercial Reader."

Second Year.

Exercises in spelling and punctuation (continued).
Essay and letter writing, with attention to matters of style, paragraphing, choice of correct words and phrases.
Synonyms, opposites and correlatives.

Reading practice:—
Shakespeare. 1912-13, "Richard II."
Pitman's "Commercial Reader" (or History).
Oral treatment of subject matters of lessons and essays on correlated themes.

Books used: As in first year, with addition of Pitman's "Commercial History."

Third Year.

The students now attend for a longer period in English than in the earlier years. With a view to business training, *précis* becomes an important exercise; but the other exercises in composition (both essays and letter writing) receive great attention. Topics of current interest—*e.g.*, The War in the Balkans, The Insurance Act—are explained, and become the subjects of essays. Extension of vocabulary—by reading, the use of the dictionary, and by conversation. A course of lessons on London—based on Dr. Foat's "London" (Methuen). Essays on subjects arising out of these. Much individual teaching given in these later years—by revising exercises with the pupil.

Reading encouraged.
Home Reading—"Pickwick."
"Esmond," &c., &c.

Fourth Year.

Précis of a more commercial and technical character. Compositions on more difficult themes. A short course on English literature—with study of Shakespeare. [1912-13, "Richard II."] "Citizenship" or "Civics" to be taken with an intelligent class.

Books:—Commercial *Précis*.
Macmillan's "Advanced Reader" (Literature).
"Duties and Rights of Citizenship" (Aston).
"The Industrial Revolution."

Fifth and Sixth Years.

Instruction in English less formal, and, at the desire of the Company, reading in standard literature, including lives of successful business men. Discussions on topical and business subjects by the lads themselves, after directed preparation of the selected subjects.

General Comments on the English Course.

The scheme for the instruction of the gas-fitter apprentices at the Westminster Technical Institute includes a continuous course in English—in other words, alongside with the special technical work in theory and practice in the workshop, the class-room, or laboratory, there is a further training in matters intellectual not arising out of the technical side of the work, yet aiding it somewhat, by assisting the student to express his ideas better, and encouraging him to think for himself. The course provides a thorough grounding in composition, and a literary training. The composition includes spelling, punctuation, order of words in sentences, with special attention to letter writing, *précis* and essays. Reading good literature, with a more detailed study of it in advanced classes, is specially provided for; and when a lending library is started, it is hoped that this will be carried on to an extent which will be beneficial both now and in the after life of the lads.

But it would be as well, before going any further, to consider the class of lads attracted to the work, the status of their previous training, and the facilities they have of improvement. My own experience here is, of course, limited—but a twelvemonth spent in all the classes at the Institute, combined with nearly thirty years' labour in very similar work among boys, drawn from almost identical schools and of the same age, entitles me fairly to give an unbiassed opinion. I have previously been a master in those excellent Training Schools for Pupil Teachers.

The gas lads are drawn from almost identical classes of society—as shown by the schools from which they come; age also is the same. Now what struck me most when I first took charge was (*a*) the very great unevenness in results of the boys in the same class; (*b*) the excellent mental capacity of the top boys; (*c*) the general ill manners and idleness displayed in almost all sections; and (*d*) their willingness to be helped.

. . . I have referred to the excellent mental capacity of many of the lads—that is, in my subjects—but I am not so foolish as to imagine that my subjects are the only ones in which mental capacity can be shown. A lad who can only feebly express his ideas, whose memory for spelling and such matters may be defective, may yet at the same time be an excellent workman. I have been struck with this on many occasions. I recollect taking into a section a small model of a gas-engine which a student in another part of the Institute had made. At once the attention of the lads was changed—the facial expression was most noteworthy; the careless laughing mood was gone, All eyes were fixed on the model which one lad held; the others discussed its merits (and demerits) in a way which showed how keenly they were interested.

So, when taking correspondence with them, dealing with matters relating to the Gaslight and Coke Company's business, there was the same interest shown; while giving them the necessary facts relating to a geyser, in order to write to a consumer, all were prepared with questions relevant to the matter, often offering information. And I often notice a lad, who seems dull with me—or rather with my subject—to be very good in his mathematics or technical work, but usually one may take it, if a lad is weak in English, he is probably the same in other departments of mental work.

As to "manners" and "conduct"—the roughness and rudeness struck me as very remarkable in contrast with those of the same age and social status whom I had previously been teaching. Gradually much of this has disappeared. The steady support of the Company (leading to the suspension of two lads) made itself felt; and as the awards for prizes came to be known, and it was seen that results in English were almost the entire cause of the first prizes—certainly in the evening sections—the importance of the subject came to be realized. There is no part of my work which is so satisfactory as this. Gradually distrust has given way to trust, attention has taken the place of listlessness or even disorder, and classes work with their teacher rather than against him. Punctuality is almost completely established, and now it is the rare thing to find a lad late.

And so with the last thing. As soon as the lads found out that every help to improve them was to be had, they earnestly threw themselves into the plans, and by giving them individual help there has been a great advance. Much use has been made of passing events to improve their general knowledge and intelligence. Lessons on "The War," "The Budget," "The Insurance Act," "Election of the London County Council," and many other topics have been given and used as subjects for composition.

Developments are taking place, too, leading to higher and better work. Section 1 began a debate on April 8 on "Compulsory Military Service." A course of literary lectures on "Milton and his Times" will also be given. In Section 2, a history course on "The Nineteenth Century and Industrial Progress" begins; and it is hoped that courses of lectures on "Civics" and Historical and Literary Series will eventually become a recognized part of that higher English work for which a technical institute is suitable.

I append sets of papers* from the different sections which I have explained here and there. It would have been easy to have multiplied them; but I think they are fairly representative of all the sections, though not altogether of every kind of work included under the general term of "English." And, after all, there is much teaching which can never be tested by written papers, but which can be evidenced in "character" and "self-respect."

LECTURES IN GAS SUPPLY.

The lectures in "Gas Supply" given to the apprentices are on lines very similar to those adopted at all centres where this subject is taught. To make this paper as complete as possible for purposes of reference, I have given the detailed syllabus of these lectures in Appendix D. The principal lecturer, in his report, states that—

After all lectures, questions are invited and answered. Home work is also given (three questions each night).

Workshop practice at the Institute in connection with these classes consists of cutting and screwing barrel, various types of dies being used; bending of pipes by forge and machine: joint-blowing in lead and compo pipes; bending of lead pipe for meter fixing; brazing;

(* Not included in this paper.)

forge work and fitting copper tube for illumination devices; making of lamp irons; testing various systems of water-heating by experiments; drilling holes in mains; cutting-out; and joint-making.

Instruction in the Advanced Gas Supply Classes.

Prior to the present session, the lecture classes were two in number. A third class was arranged for at the beginning of the present session to provide instruction for apprentice students who had secured a second-class pass in the ordinary grade. It was thought inadvisable to allow them to go straight to the honours grade; but at the same time it was considered that they should continue their studies on a higher level than that provided for in the ordinary class. The instruction given in the new class has been, as far as possible, intermediate between the two other classes. So that, though the students will enter for the ordinary grade examination this year, they will have anticipated the higher grade to some extent; and this should help them in the more difficult studies next year.

In carrying on the two higher classes, the City and Guilds syllabus has been followed as closely as possible, but departures have been made in directions in which it has seemed advisable, having in view the daily work of the students.

My experience in connection with the classes has convinced me of the advisability of preceding the study of any definite aspect of gas supply by a short review of the fundamental principles involved. These grasped, the students pass to the study of the practical aspects with comparative ease and, I believe, increased interest.

It has always seemed to me advisable to follow up these various studies by an actual working example, this giving the student an opportunity of seeing the right relation between theory and practice. Apparatus and appliances are on view (often in operation) whenever possible—not with a view merely to showing them to the students, most of whom become more or less acquainted with them in their every day work, but rather with the idea that the presence of the apparatus will suggest questions to the students. Many of them take advantage of this, and at the conclusion of the lecture an informal conversation usually takes place round the lecture table; and I have reason to believe that this is appreciated.

The course of instruction covers the whole field of gas lighting, heating, and power, except the application of gas to furnace heating. It has been considered advisable to deal with this subject (furnace heating) in a separate course and by a special lecturer.

A special feature of the "Gas Supply" course is the opportunity given to the students to make experiments with various appliances—such as heat, light, and power determinations—gas fires, lamps, burners, water heaters, gas-rings, gas and hot-air engines, being used for the purpose. These opportunities enable the students to get into living touch with the subjects dealt with during the lectures, and add increased interest to the instruction given.

"I have formed the opinion," says the Principal, in the conclusion to his Memorandum, "that this scheme of instruction, coupled with the encouragement offered by the Company, has had a salutary effect on the other employees of the Company in stimulating them to go in for technical education; and this should have an excellent effect all round. I do not know how far my opinion is borne out by facts."

I am certainly able to endorse Mr. Stuart Ker's opinion in regard to the steady growth of students throughout the department, which has gone far to solve the problem of how to ensure that men who entered the service in the days before modern methods were adopted, shall raise themselves to the present-day standard of qualifications.

I have now completed my account of the work which is being done by a large gas company in co-operation with an educational authority which is certainly alive to its responsibilities and opportunities. I have purposely made the account as detailed as possible, because I cherish the hope that it may be the forerunner, and therefore be of some use in the initiation, of similar schemes for co-operation between the industry and the educational authorities elsewhere.

A Suggestion.

Is there any reason why the gas undertakings in different parts of the country should not join together in such work, and co-operate jointly with the county authorities, as we in London are co-operating with our county authority? Is there not a demand for skilled fitters and technically qualified officers in the districts around (say) Birmingham, Manchester, Newcastle, Glasgow, Liverpool, Cardiff, and Exeter—to mention a few of many possible centres—that would justify establishing apprentices' training shops in all these centres, and the circulation of the lads among the surrounding undertakings for their district experience?

Is there any reason, either, why, by such co-operative means, lecture centres for the technical and commercial training of staff officers, or aspirants for staff appointments, in the public service branch of the industry, should not be established generally?

I commend the suggestion to the careful consideration of all progressive men in the industry, with a confidence which is based on over four years' practical experience of experiments that promise to bear fruit in a measure exceeding the anticipations of those by whom they were inaugurated.

This question of organized education for those engaged in the distributive (which includes the selling) side, as distinct from the manufacturing side, of industry is at the present time engaging the attention of educationists in all parts of the world, as it is becoming more and more widely recognized that supplying, not making, is the ultimate foundation of trade. It may therefore well command the attention of the gas industry in the near future.

APPENDIX A.

THE GASLIGHT AND COKE COMPANY'S STAFF INSTRUCTION.

Examination Paper for Division "A" Students, April 12, 1913.

Important.—*Students must not answer more than ten questions in all, but must include in the ten questions answered the seven that are starred.**

The maximum marks obtainable for answers to the questions are shown in brackets at the end of the questions. Additional marks (not exceeding 30 in all) will be awarded for neatness and general intelligence.

1.* Explain the action of a U-gauge for measuring the pressure of gas, and how to read it. State the equivalents of water and mercury for this purpose. Express a gauge pressure of 4 lbs. per square inch in equivalent terms of mercury and water gauge pressure. [25 *marks.*]

2.* State the extremes of gauge pressure, high and low, you consider permissible for the good working of all ordinary private consumers' apparatus. What remedies would you propose on finding excess or deficiency of pressure on consumers' premises? [25 *marks.*]

3. Give Boyle's law for the relation of the absolute pressure of a gas to its volume. Correct a meter registration of 10,000 cubic feet of gas measured under a gauge pressure of 5 inches of mercury to the quantity properly chargeable. [25 *marks.*]

4.* What do you understand by the statutory candle-power of the Company's gas? How does this figure compare with the average candle-power realizable with the principal types of burners actually in use by the public? State as many different burner efficiencies as you remember. [25 *marks.*]

5. What is the meaning of the term "foot-candle"? What is about the amount of illumination desirable for easily reading the whole of a newspaper? [25 *marks.*]

6. What is meant by "glare" in artificial lighting? How can it be avoided? Sketch some forms of shades and reflectors stocked by the Company; and briefly state their particular objects. [25 *marks.*]

7. Specify and estimate for supplying and fixing a set of 4 high-power low-pressure outside shop lamps (calculated to give a brilliant effect against flame-arc electric lamps) on the Company's hire system. Show annual revenue and total costs. [30 *marks.*]

8. What quantity of gas per hour would you expect to supply through 100 feet run of clean, straight, and level 1-inch service pipe, with a loss of pressure of not more than three-tenths between the street main and the meter inlet? [25 *marks.*]

9.* How would you judge a good gas-fire? What should be the gas consumption for comfortably warming sitting rooms by this means of 1000, 2000, and 3000 cubic feet capacity, respectively? Describe and give a sketch of Browning's down-draught prevention device. [30 *marks.*]

10.* Give a short statement of the comparative advantages and drawbacks of warming living rooms by (*a*) coal fires; (*b*) anthracite stoves; (*c*) hot-water pipes heated by gas or coke; and (*d*) gas-fires. Is a bowl of water necessary in front of a gas-fire? Give reasons for your answer. [35 *marks.*]

11. What is the scientific basis of comparison for the respective heating power of gas and electricity? [25 *marks.*]

12. It is reputed that the gas-engine is the most efficient agent for converting the energy of fuel into mechanical power. Can you explain why? [30 *marks.*]

13. What are the limits between which mixtures of gas and air are explosive? State the approximate proportions of gas and air which will give the most violent explosion. [25 *marks.*]

14. How would you treat a person who had been badly "gassed"? [30 *marks.*]

15.* Describe briefly the different methods of obtaining hot-water supply, independently of the kitchen fire. [30 *marks.*]

16.* Draft a letter to a person living out of London who you learn has taken a house in the Company's district. [30 *marks.*]

Examination Paper for Division "B" Students, April 12, 1913.

Important.—*Students must not answer more than nine questions in all, but must include in the nine questions answered the six that are starred.**

The maximum marks obtainable for answers to the questions are shown in brackets at the end of the questions. Additional marks (not exceeding 30 in all) will be awarded for neatness and general intelligence.

1.* Explain the action of a U-gauge in measuring gas pressure; and how to read it. State the equivalents of water and mercury for this purpose. Express a gauge pressure of 4 lbs. per square inch in equivalent terms of mercury and also of water gauge pressure. [25 *marks.*]

2. What is the proper working pressure for ordinary consumers'

appliances—lamps, fires, &c.? What would be the effect upon the consumption of doubling the pressure? [20 *marks.*]

3.* Sketch in section and explain the working of a good consumers pressure governor. State the requirements of a good governor of this kind. [25 *marks.*]

4.* If sent to attend to a complaint of "bad gas" or "bad supply," what would you proceed to do? Give your answer in the form of a report to the office. [25 *marks.*]

5. What is the essential principle of a high-power, or intensified low-pressure inverted lamp, which makes it different from a common inverted lamp having the same number of mantles? Which kind of outside shop display lamp gives the least trouble in maintenance—high-pressure or intensified low-pressure? What are the commonest defects of each type of lamp? [30 *marks.*]

6. Describe, with sketch, two different styles of shop window lighting from inside, giving details of the power of the lights, kind of shades or reflectors used, and method of ignition. [30 *marks.*]

7.* Explain, by successive steps, the effects of adding air to gas before burning. [25 *marks.*]

8.* Where is the hottest part of a gas flame to be found? What use is to be made of this knowledge in applying gas to lighting and fuel purposes? [30 *marks.*]

9. How is heating power measured? State the heating power of a cubic foot of Company's gas. Is it possible to increase this power by any modification of the burner? [25 *marks.*]

10. How much gas must be burnt to warm 25 gallons of water from 45° to 110° Fahr., allowing the apparatus an efficiency of 85 per cent.? [25 *marks.*]

11. If in a household hot-water circulating system cold water follows the hot a few minutes after the hot tap is opened, what is wrong? [30 *marks.*]

12.* Write a letter in reply to a consumer who asks: "Are gas-fires economical in comparison with coal?" [30 *marks.*]

APPENDIX B.

THE GASLIGHT AND COKE COMPANY.

APPLICATION BY A LAD WHO DESIRES TO ENTER THE COMPANY'S TRAINING SHOPS.

	Surname.	Christian Names.	Age next Birthday.	Date of next Birthday.
Name ..				
Where educated ..				
Height _____	Weight _____	Address _____		
Occupation of Parent or Guardian		Declaration by the lad making application: I have read the particulars given on the other side hereof, and, if selected, will do my best to carry out faithfully the rules and regulations of the Gaslight and Coke Company. _____		

I, the (parent / guardian) of the lad named above, agree to his undergoing a course of training with the Gaslight and Coke Company upon the conditions set out on the other side hereof, which I have read and understand. I undertake to maintain the lad during his training, and at all times to permit and give him facilities for carrying out the rules and regulations of the Company. I agree that, in the event of his discharge, I shall have no claim for compensation from the Company.

Date _____ _____

Signature of Parent or Guardian.

REPORT OF HEADMASTER.

(1.) Classwork (Standard reached)—

(2.) Manual training work—

(3.) General—

_____ *Headmaster.*

APPENDIX D.

SYLLABUS OF LECTURES TO APPRENTICES AND OTHERS IN GAS SUPPLY.

Station Governors, their objects, action, and construction; where and how fixed; bye-passing; plans, models, and types of governors; weight and water loading.

Pressure.—Definitions of, and equivalents in water, mercury, and pounds to square inch; working and standing pressure; how influenced by rises and falls; demonstrations to explain pressure and volume; influence of various pressures on burners and appliances; pressures necessary and most effective for flat-flame, argand, upright and inverted incandescent burners, self-intensified and high-pressure lamps, cookers, fires, water-heaters, gas-engines; pressure gauges and recorders and how to read them.

Distribution of Gas.—Explanation of the Company's system in comparison with that of small towns, various towns and position of works and mains being described; points to be borne in mind in service-laying; nature of soils and positions, such as roadway, sidewalks, wood, asphalte and macadam; comparing prices of material and labour; laying mains—dead and alive; methods of testing; depths; levels; uses of receivers and all irregulars and fittings used for main work; cutting-out large and small mains; bagging-back; use of riders; comparisons and advantages of cast and steel pipes; sizes and thicknesses of pipes used; methods of manufacture and testing; defects and remedies of naphthalene, corrosion, water-logging; escapes and electrolysis. Plans and actual fittings used on various kinds of mains.

Joints and Joint-Making.—Demonstrating how to make lead, lead wool, iron cement, portland cement, turned-and-bored, rubber ring, flanged and saddle joints; method of fixing Ruscoe split tees; plans of all types of joints, with comparisons and advantages.

Services.—Definitions of; sizes; materials used; methods and positions in laying; points to follow and to avoid; defects, how to locate and remedy; types of fittings used; inserting tee on live service and precautions to ensure safety; connecting to main; top and side holes; drilling and gouging—points for and against.

Unaccounted-for Gas.—Causes of.

Discharge from Pipes.—Velocity, friction, length, size and specific gravity; tables of discharges from ¼-inch to 2-inch pipes at various pressures and lengths; simple method of obtaining discharge from pipes of larger size.

Meters.—Brief history of methods of charging previous to Clegg's first meter; object, action, and construction of, and material used for, wet, dry, and rotary meters; sizes made, showing models and glass case meters; parts and plans of all types; automatic and stop mechanism; action of coin and price-changing arrangements; fixing, bye-passing, and repairing meters; positions—good and bad—in which to fix meters. Official testing.

Plumbing.—Various methods of making joints; bending of lead pipe; all necessary points in regard to joint-making. Tools used, and how to use them.

Alloys.—Definition and names in general use; how made and component parts; melting points of all alloys and metals. Solders, hard and soft; how made, and various fluxes used for soldering.

Description of Pipes used for internal fittings; compo., barrel, tin, lead, brass, copper; advantages and disadvantages of each; sizes to use, and amount of gas required for all types of burners and appliances from flat-flame burner to gas-engine; also sizes laid down by Newbigging; plans and sketches showing carcassing of automatic installations, six and nine roomed houses, factories and shops; positions of pipes and risers; what to avoid; methods of running; positions of points for distribution of light; construction and objects of Anti-Vibration and counterbalance pendants, water-slide and stuffing-box pendants. Methods of converting hydraulic chandelier to fixed.

Governors, their uses and action, showing all types—mercury, diaphragm, steatite, and white metal float; constant volume and constant pressure governors; positions in which they should be fixed, and sizes.

Luminous and Bunsen Flames, describing the theory, uses, construction, and advantages of both; calorific value of gas, comparisons of calorific value of gas, coke, coal, petroleum, electricity, &c. Demonstrations of defects of bunsen burners; tables of flame temperatures.

Simple Means of Ventilation.—Necessity and methods of ventilating small and large rooms, halls, schools, hospitals, explained by the aid of sketches. Amount of air required for human beings, and all data concerning carbonic acid and organic matter; advantages of gas compared with electricity as a ventilating agent; causes of dirt on walls and ceilings—extracts from Dr. Toogood's and Professor V. B. Lewes's papers read. Tables of explosive mixtures, describing their meaning.

Influence of Shades and Globes and Wall Papers on light efficiency; uses of reflectors.

Construction of Burners.—Flat-flame, argand, regenerative, and incandescent; their efficiency and consumption; regulation of air and gas supply to burners; defects and remedies; outside shop and public lighting; various forms of low-pressure, self-intensified, and high-pressure lamps and burners. Suspension brackets and lamp columns and methods of fixing; high-pressure distribution for lighting.

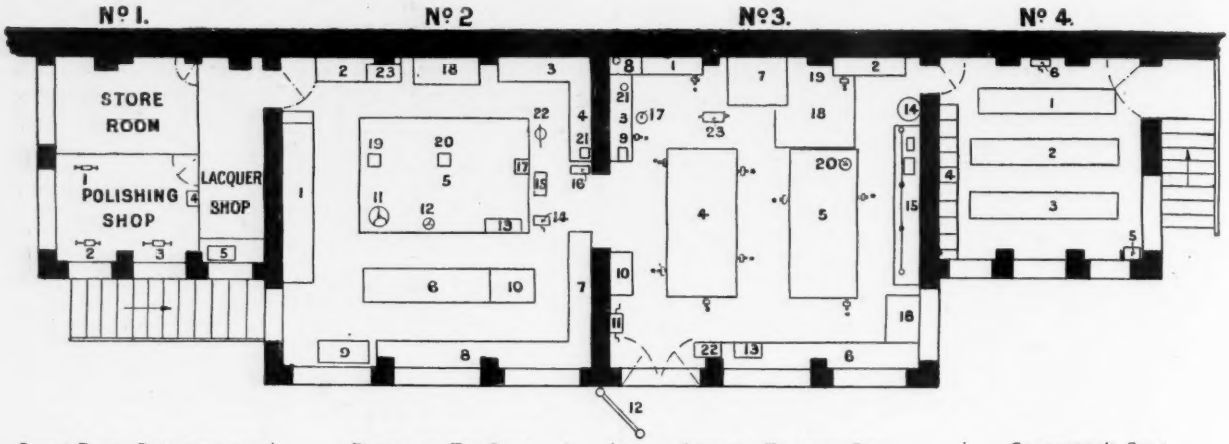
Cookers and Heaters, self-contained and in grate; fixing and construction of all types of stoves; radiant and convected heat; defects and remedies; down-draught, &c.

Various Systems of Gas Water Heating.—Principles of construction of geysers, circulators, and califonts.

The Gas-Engine, its Construction and Efficiency.—Methods of fixing; running gas ignition and supply and water pipes; tanks; exhaust; use of silencers, &c.; sizes of pipes, &c.

APPENDIX C.

PLAN AND EQUIPMENT OF TRAINING AND WORK SHOPS AT HORSEFERRY ROAD, WESTMINSTER.



STORE ROOM, POLISHING AND LACQUERING SHOPS.

1 to 3. Polishing Machines.
4. Hot Sawdust Box.
5. Heated Lacquering Table.

BRASS AND TIN SHOP.

1 to 8. Benches.
9 and 10. Lathes.
11 and 12. Drilling Machines.
13. Sheet Metal Folder.
14. Grindstone.
15. Sheet Metal Cutter.
16. ,, ,, Roller.
17. ,, ,, Circular Cutter.
18. Brazing Forge and Bellows.
19, 20, 21. Tinman's Soldering Stoves.
22. Mandril and Block.
23. Levelling Plate.

GENERAL TRAINING SHOP.

1 to 6. Benches. 7. Forge.
8. Sink with Circulator over.
9. Screwing Machines.
10. Fitting Cupboard.
11. Windlass for Crane. 12. Crane.
13. Brazing Forge and Bellows.
14. 1oft. Holder.
15. Testing Bench with Float and Meters.
16. Instructor's Desk.
17. Hydraulic Pump.
18. False Wooden Floor Section.
19. Register Grate (for Gas-Fire Fitting).
20 and 21. Bending Machines.
22. Foot Lathe.
23. Anvil. * Vices.

CARPENTER'S SHOP.

1 to 3. Benches.
4. Lockers and Hat Pegs.
5. Gas Cooker.
6. Grindstone.

DISCUSSION.

Mr. A. MORTON FYFFE (Nelson): Though the expression is stereotyped, I wish to assure you of my sincerity when I say how very highly I appreciate and value the paper that has been contributed to this meeting by Mr. Goodenough. Every member who has studied the paper must have been struck with the extremely concise and comprehensive manner in which the subject is dealt with by that gentleman. At the commencement, the need for this training, and the method of the training, are carefully stated, and are divided into three distinct divisions or heads, as follows: (1) The training of lads to be skilled and intelligent mechanics from their school days onwards. (2) The question of improving the knowledge and skill of grown workmen who have entered, or may enter, the services of a gas undertaking without having been trained upon scientific lines. (3) The training of lads to be men possessing commercial ability and acumen, as well as scientific knowledge of the technicalities of the industry.

It is refreshing, in these days of systems of positive education, to have an authority such as Mr. Goodenough emphasizing the fact that mere knowledge is not education, but rather that only when the knowledge is assimilated in such a manner as to make its devotee a more useful, helpful, and interesting member of society, is it worthy of the name of education. I would, however, venture to disagree with Mr. Goodenough when he suggests that a man is very little aided by the knowledge he took so many years to acquire at school. I grant that the actual components of elementary education are not often re-called in professional or business life; but may it not be the case that the capacity of the young man for acquiring and utilizing scientific and technical knowledge is largely dependent on his elementary education as a boy? I would suggest to Mr. Goodenough that the ferro-concrete raft which carries the installation of vertical retorts is vitally important, though an unseen and underground part of the structure. In the curriculum of education outlined by the author in the paper, I note with great interest that there is no formal syllabus, and again that the lecturer is also the examiner. Here we find the conventional ideas of education have been broken through by practical men to obtain practical results; and the system adopted should lend itself to schools and universities whose aim is true education.

Excellent as is Mr. Goodenough's suggestion of training centres for gas department assistants—such as fitters and outdoor assistants—I foresee difficulties, especially in so far as municipal gas undertakings are concerned. Not that I think the scheme cannot be managed, but I think it is so excellent a scheme that it ought to be faced, and the difficulties dealt with. The policy of local administration of municipal undertakings is frequently to employ inhabitants of their own town in the corporation service. It might not be possible, for financial and other reasons, for youths to be sent and maintained in large centres during the period of their training; while in the event of trained men from the large centres being introduced into a provincial town, local irritation might result. I do not put forward these difficulties as a reason why the suggestion of training centres should not be adopted, but solely because I think the suggestion a good one, subject to certain difficulties being met and overcome.

Nothing but praise can be spoken of the cleverly-conceived six-year course in gas-fitting and maintenance work. Given due care in the primary selection of candidates, the results are bound to be satisfactory to the gas authorities and the gas consumers alike. As has been pointed out, the call for such a thorough training has been created by the necessity of having a staff capable of advising and educating gas consumers on the tremendous advantages of gas in so many different ways. As Mr. Goodenough says, what we as gas departments require in our outside work is a man who is technically trained, and scientifically trained if you like; and in this one man we must combine commercial acumen and knowledge. But this by itself is no good, unless you give the man practical and sympathetic encouragement; and I am glad to find Mr. Goodenough regards this as a fundamental part of his scheme. I am afraid that some gas engineers expect to obtain expert assistance from men burning with zeal for the industry for little more than a labourer's wage. Six years is a long period of training and study; and in order that good men may be induced to undergo this training, let us see to it that when proficiency is attained these men are rewarded in proportion to their skill and ability, as I believe the men working under Mr. Goodenough are.

I must not trespass any longer on your time. In conclusion, I wish again to thank Mr. Goodenough most heartily for the extremely useful paper which he has put before us. He has in it dealt with the scientific and technical side of distribution. It shows its author, not only as a scientifically trained man, possessing all business acumen,

but in addition it stamps him as one having a wide knowledge of human nature, without regard for which all such schemes are incomplete and futile.

Mr. R. HALKETT (Glasgow): In reading over Mr. Goodenough's paper on the creating of an outdoor staff, the great contrast in the working conditions between the North and the South of Great Britain was brought forcibly to my mind; and I wished, as I have often done before, that the same conditions could be brought to exist. Having worked under both, I can speak from experience. In Glasgow, I have the honour to serve a most progressive and broad-minded Corporation, ready to do all in their power to foster the highest aims and ideas. But a corporation is in a different position to a company. Where a company is perfectly independent, the members of a corporation are bound by promise to do all in their power to carry out the wishes of their supporters for the welfare of the burgh. Unfortunately, these wishes do not always coincide with what is best either for the particular department in question or for the men; and though one member may personally see the advantages accruing from a certain course of action, he cannot make others see eye to eye with him. Therefore, a corporation often has a steady fight to make, in order to advance in the right direction. The strenuous opposition against municipal trading made by ratepayers is now an old tale; but when I say that in Glasgow we have had plumbers come to us and thank us for the work we have put into their hands, and acknowledge candidly that they have been fighting against their own interests in opposing this trading, I think this will speak for itself, and I cannot too strongly urge all corporations to take up this branch of gas enterprise. Instead of robbing traders, we are putting hundreds of pounds into their pockets.

Mr. Goodenough will not come very much in contact, if at all, with trade unions. For instance, a knowledge of carpentering is most essential to a good gas-fitter, and is of great utility in the execution of his work in cutting boards for pipes, laying and lifting flooring, &c., and Mr. Goodenough is giving the lads of his district a splendid chance of becoming useful and capable men by giving them a training in this and other branches outside their actual trade. Yet, were this done in some parts of the country, the whole of the men would be opposed to it. To cite a case: While in Leeds, I remember having gas-fitters in a large institution remodelling the gas supplies. This necessitated the lifting and laying of floor boards, &c. Under Mr. Goodenough's conditions, his own men would have undertaken the work; but in this case a carpenter had to be called in. This entailed extra expense and more men. I simply mention this case to show the different conditions under which some work, and how they are restricted both from an economical and expeditious point of view. I think the men would take greater interest in a job that they were to begin and finish themselves, and a pride in getting it finished quickly.

There is a great dearth of sufficiently educated and trained men; but it is impossible to fill the breach by flooding the profession with men who have sat for examinations and gained certificates without previous practical qualifications. I have just recently sought to add to my staff of inspectors; and with a view to obtaining the best men, I set them an examination test. For four vacancies, I had thirty-five applicants. Among those who competed, I had several who already held City and Guilds certificates for gas supply. After marking the papers, I was able to ascertain what practical capabilities they possessed, and combined the two in making my selection. Making every allowance for nervousness, and the novelty of putting their ideas on paper, I was struck with the results; and it was brought home to me very forcibly how urgent it was for us to revise the training of the gas-fitter. I also discovered that those who held the City and Guilds certificates were far from being proficient, and were not able to obtain as much as 50 per cent. of the marks. The questions set were on subjects with which the fitter would come in contact in his daily routine; and it was a plain proof that if these examinations are to be of any value, they should include both a written and *viva voce* examination. Only in this way can a thorough grasp of a man's capabilities be obtained. Lack of education and of commercial knowledge is a serious drawback. I have known thoroughly good practical inspectors who could yet scarcely write their names, and who often, through sheer lack of commercial insight, caused endless trouble and confusion with a consumer. A knowledge of both is essential to the practical man; and one qualification is little good without the other two. In a young man there is always the hope that he will improve with added experience; but it is a heart-breaking job where the men are too old to alter their ways, notwithstanding that they are thoroughly painstaking and conscientious. Our best men are the practical men who have sought to improve their education by all the facilities within their reach; and it is our duty to put as many of these within their reach as possible. Upon them rests the fame of gas as a household commodity.

The satisfactory results of a well-fixed fire, cooker, water-heater, or any other appliance rests with the fitter; and as these come into common use and knowledge, a greater field for labour lies before him both with the makers' appliances, as his business grows with the progress of gas, and with the gas undertaking, whether it be company or corporation. A great difficulty exists in the men not realizing their inefficiency. They do not realize that the work of a fitter of ten, or even five, years back is very different to what it is to-day. The advance of modern gas appliances has changed his work from a mechanical one of fixing gas-pipes to one requiring intelligence and skill; and the inspector who supervises the work needs to know the appliance, and its capabilities, as well as to be able to talk intelligently and tactfully to a consumer. He should, in fact, have been a fitter, and gained advancement by competency and qualifications; and it is only by the youths having a sound education before taking up the profession, and by such training as Mr. Goodenough has put forward, that this end can be obtained. Perhaps from a corporation point of view the scheme would require modification; but only by these or similar methods is it possible to bring the gas-fitter to a state of efficiency.

Mr. J. G. TOOMS (Waterford): I certainly, as I am sure do all the members present, consider this paper a most interesting one. I propose to somewhat criticize the scheme as it deals with the taking on and training of apprentices. To my mind, this is the most important part of the paper, because any real advancement in the attainments of fitters or the general staff of the workmen employed in any undertaking must commence from the foundation. All employers will agree that a higher degree of technical knowledge and mechanical skill of the employees in any industry is a matter greatly to be desired. I propose, Mr. President, as I said before, to somewhat criticize portions of the scheme, and, if time permits, to endeavour to explain to you a scheme that has been in operation for some years with most successful results on a moderate scale, and which to my mind is more applicable to small undertakings than the scheme expounded in the paper. I desire to emphasize first of all that this scheme—suitable as it is for the great Gaslight and Coke Company—may possibly be applicable to a score of other undertakings in the United Kingdom; and though it cannot be denied that helpful suggestions may be obtained from the paper by some members, it must be remembered that the membership of the Institution is largely composed of men engaged in moderate and small sized undertakings. I beg leave to suggest that if Mr. Goodenough, with his vast knowledge and experience of this question, had descended from his high pinnacle to the level of the requirements of undertakings smaller than his own, and had drafted a scheme suitable for such undertakings, the value of his paper would have been vastly increased. Mr. President, I shall, if time permits, outline a scheme which has been in operation in Waterford for over four years, which is applicable to almost every undertaking in the kingdom, and which has produced results relatively easily comparable with those described in the paper.

Throughout Mr. Goodenough's paper, there is quite properly wholesale condemnation of the system of elementary education. Figuratively speaking, Mr. Goodenough holds up his hands in pious horror at the iniquities of the Commission that is charged with elementary education. He calls in for corroboration Mr. Stuart Ker, the Principal of the Westminster Technical School. For what? To demonstrate a fact with which everyone agrees. I venture to say that Mr. Goodenough's own scheme is equally open to condemnation, because, admittedly, he takes on boys as apprentices—or rather his scheme does—who are badly equipped educationally, and, to my mind, of much too tender years. After four years of this special training, which is so well described, with the resources of this great Company,

under the fostering care of Mr. Goodenough, Mr. Stuart Ker, and all their assistants, only two out of 26 boys are able to write an essay free from errors in spelling. This is a clear indication of the inefficiency of the scheme we are considering; and I might, if so disposed, use many of the author's arguments in condemnation of his scheme. Other people and employers interested in this question in other parts of the kingdom and in Ireland have the same difficulty; but I submit that no real attempt has been made, so far as is shown in the paper, to grapple with this difficulty in the case of the scheme outlined. In other parts of the country, the difficulty has been met and grappled with, and to some extent has been solved by the aid of trades preparatory schools. These schools, as their name implies, are capable of being a great force in the country and in the direction in which Mr. Goodenough is working. In these pre-apprentice schools, boys are required to serve two years. The condition of their entrance into this course is that they should have reached the seventh standard. The qualification is practically the same as admits boys into the service of the Gaslight and Coke Company; and they have two years to serve in this preparatory school.

If I describe what has been done in Waterford, it will illustrate my line of argument better; and for this purpose I shall have to refer to some notes that I have here. We have made it a condition that all boys applying to us before admission have spent two years in the trades preparatory classes of the local technical school. The age of entry to these classes is from thirteen to fourteen years; the average being fourteen years. The boy is consequently sixteen years of age on completion of his trade preparatory school course. The chief subjects dealt with in the first year are commercial English and geography, experimental science (elementary physics), practical mathematics, manual instruction in wood, freehand drawing, and geometry. Instruction is also given in a modern language and physical drill. The second year's instruction includes, besides the above (under experimental science), elementary chemistry, physics, and mechanics, as well as manual instruction in metals. About twenty hours per week instruction is given in mathematics, experimental science, manual instruction, and geometry and drawing, and eight hours to the other subjects. The various subjects are dealt with by the expert instructors engaged for evening school work; and consequently the training is of the very best type and superior to that in elementary schools, where the staff is necessarily restricted. So much for the trade preparatory course.

The boys now enter on apprenticeship, and on two afternoons weekly are sent to the day-classes for apprentices at the technical school. I may here state that, since the scheme was started, the commencing wages of apprentices have been advanced by 4s. per week, to attract a better educated type of boy. It was 8s. commencing; and we considered that the boy is well worth the difference. When we take the boy in hand, he has a good grounding in the use of tools, as well as the names of them, and he is familiar with the principles underlying the work. We usually take two apprentices each year. The first duties are cleaning up the shop, running errands, &c., until they are attached to a fitter or other workman, when we give them all the training that the size of our undertaking admits, under a well-qualified foreman. As soon as they have the necessary confidence, and are considered trustworthy, in from $3\frac{1}{2}$ to 4 years, they are put out, as we say, on their own—at first, of course, on unimportant jobs. As we do practically all the gas-fitting in our area, up to thirty miles away from Waterford, the apprentices get a good insight into all that appertains to the public side of gas supply. During their apprenticeship, besides attending the day apprentices' classes, all boys are required to attend evening technical classes; but they are given time off till 9 a.m. the morning following a night's attendance at school. ["Hear, hear."] I may say we find that allowing this quarter off is considered by the boys to be a great boon. But the principle underlying this compulsory education of the fitters that we take on is this—that, in my honest opinion, parental control over boys is becoming somewhat lax. A boy does not know what is good for him till he gets to be seventeen or eighteen, and sometimes he never knows. But there is no excuse for us. We know what is good for him; and I think it is quite a reasonable and proper thing for us to compel these boys, if they come into our employment, to improve themselves. We insist on this, because, after one or two years, they get a liking for the instruction, and they would go in for it, I am quite sure, voluntarily, though we stipulate that they shall go to evening classes during the whole term of their apprenticeship to us.

I have with me particulars of the four years' courses of instruction provided by the Waterford Technical School, which I do not propose to inflict upon you. But I shall be pleased to let the Secretary have them, if he wishes it. They have been supplied to me by the Principal of the school, who, I may here state, has always taken a warm interest in our efforts, and is always open to meet our views as far as possible as regards the matter of arrangement of the classes. I have only further to point out that such a scheme as that I have outlined is within the reach of almost every undertaking; and from my experience I have no hesitation in stating that the results to be obtained will much more than justify the means.

Mr. W. R. Herring (London): We have before us here a subject which I am sure we could discuss for the rest of the day. It is for this reason, and knowing that there are diverse views necessarily due to different localities, that I think one might reasonably call attention to Mr. Goodenough's suggestion as to undertakings co-operating in founding some general scheme of education for fitters. My own experience is similar in many respects to that of Mr. Goodenough. I have found that the raw material available is of a very unstable kind. The boys seem to know nothing, and have not even had the character formed which is supposed to be the basis of elementary education. In Edinburgh, some years ago, we did introduce a system of indentured apprentices for gas-fitters, who were not only to be trained in the particular branches of the gas-fitting business, but were also to be educated in such a way that they could become meter-readers and inspectors; and those who were otherwise fit were open to take appointments on the clerical staff. We thought by opening up the whole clerical staff we should encourage a type of lad to come to us which is the type that we really seek, because, after all, technical education and skill, and ability in the doing of the particular work they have to do, is undoubtedly a great deal. But we must not forget that it is these very men who are the embodiment of the gas company or the gas corporation, whichever it is, who come into contact with the consumers. Our consumers see very little of any other representative of the gas department except men who go round to investigate complaints, read meters, or present bills.

There is just one point, and I think it is the only point, that Mr. Goodenough seems to have omitted from his most comprehensive treatise. He does not appear to have dealt with the human side of his elements. I think, Sir, a study of humanity and ability to read the thoughts of the person one meets at the moment of contact, particularly when that person is grumbling, is a great acquisition. It is most necessary to be sympathetic; and though you are quite prepared to tell the consumers that they are wrong, to tell them this to begin with is a fatal mistake.

With regard to our scheme in Edinburgh, it has worked on the whole very well; but I am sorry to say, though our scale of pay is, I think, 18s. in the fifth year of apprenticeship, it is not encouraging the type of lad or the numbers that we would like to see coming forward. There is a terrible want of earnestness in the youth of the present day; and though I believe an apprentice in the old days probably got no more than 10s. a week in his last year, nowadays a matter of 18s. a week is scarcely sufficient to encourage them to come forward. There is one other point that I wish to mention, and that is as to the medical fitness of the boys. I can only speak of Edinburgh. There we have made an informal examination of the youths before allowing them to come into our employ at all; and then, before entering into indentures, which was one year after commencing service, they were medically examined. We, however, found that so many of them were physically unfit that we were obliged to institute the medical examination at the very outset of the employment. I think that this is certainly a somewhat alarming aspect; and I would suggest to any others who are taking lads into their employ to make craftsmen of them, that the first thing they should have is a medical certificate of their fitness to be trained.

Mr. H. Kendrick (Stretford): As a representative of the gas companies of Lancashire, I welcome Mr. Goodenough's paper as a basis to work upon. Mr. Goodenough himself will not claim that it fits all cases. Probably it will not

fit the case of the Manchester area, which is largely dominated by corporation undertakings; but it is for the committees to be formed under the scheme of education adopted on Tuesday last to decide and to formulate. I thank Mr. Goodenough for laying before us so fully the work done on the educational question by the great Company he represents. There is one matter he mentions which has not perhaps been dealt with so fully as some of us would like, and that is the question of wages. If we in the Lancashire area, and I think it will apply also to the West Riding of York, adopt what is the practice among gas companies generally, and some few of the larger corporations—such as Birmingham and Glasgow—we shall have to pay a very much higher rate of wages than the scale which has been mentioned in Mr. Goodenough's paper. It must be remembered that, in our particular area—and I think that it applies very largely to the North—the gas-fitting trade is in the hands of the plumbers; and as they pay from 9½d. to 10d. per hour, if we are to get the best of their men to do our work for us we shall have to pay wages somewhere in the same neighbourhood.

Then there is another question in the North, and that is the difficulty of getting gas committees to undertake this work. They seem afraid individually of a few isolated men in each of the wards they represent, and hesitate to enter into what the plumbers state is competition with themselves, because they might perhaps, by the turnover of a dozen or twenty votes, lose their seats at the next November election. These are very real things to our corporation representatives. Then with regard to the work done by these plumbers, those of us who were present at the conferences which we held both in Leeds and in Manchester, when the scheme which you adopted on Tuesday for the education and certification of gas-fitters was formulated, will remember that the trade representatives there claimed that the only men who had a right to do gas-fitting were men trained by the plumbers themselves, and they claimed also that the gas companies were going outside their province, were robbing them of their work, reducing their profits, and in the end might even reduce a great many of them to beggary. The answer that we made to this was that the work which we were undertaking they never had, that it was entirely new work, that it would add to their profits if we undertook it, and that even if the gas undertakings did most of the work there would be still sufficient left for them in order to increase their profits. The aim of a good many of us in the North is to do what obtains both in the Midlands and in the South—that is to say, divorce gas-fitting from plumbing and set up an entirely separate race of tradesmen. We found as distinctly as you have in the South that the vast majority of these men are not at all trained; and the sooner we enter on this work, the better it will be for the gas undertakings generally.

There was one remark made by a previous speaker which I should like to draw attention to; and I think if he were to once more read through the scheme of education that has been adopted by the Institution, he would see that his objection is there provided for. We know very well that small works cannot expend so much money as has been suggested by Mr. Goodenough in the setting-up of workshops and training centres. They cannot do this singly; but collectively it is possible, and I hope to see that the corporations trading in the Manchester area will be willing to help the smaller undertakings, such as I represent, by assisting us in founding such collective workshops and training centres in Manchester, as well as other corporations in the other centres, so that we can have as good an opportunity of training our own men as has been shown by Mr. Goodenough to be the case in the London area. Finally, I should like to remind the members generally that, if we are to retain our consumers and extend our business, all sentimental feelings towards the local plumber and gas-fitter must be suppressed for the general good of the gas industry as a whole.

The PRESIDENT: Before calling upon Mr. Goodenough to reply to the discussion, I will ask your indulgence for a moment or two. I have myself followed a self-denying ordinance throughout this meeting, knowing how short was the time at our disposal for the amount of work to be done; and I have several times refrained, when I should very much have liked to have taken part in some of the discussions. Upon this paper, I have only one or two words to say. First of all, it has been extremely satisfactory to find how ready, not only in London, but elsewhere, the local authorities—especially the educational sections of the local authorities—have been to act with the companies in their efforts in the direction of technical training. In the case of the County Council, I was very much gratified by a suggestion from them that, feeling as they did that it was a leading step in a direction that they would like to see followed, they were willing to establish scholarships of so much a week for a number of boys, if we chose to accept their proposal. We did not accept it; and I think we were right in this, because we felt that we ought to keep the right to retain only those boys who were quite satisfactory in the way they carried on their work. With regard to the application to small companies, I think the gentleman who raised this point rather lost sight of the suggestion made in Mr. Goodenough's paper as to the establishment of centres in different parts of the country, where this training work could be carried on by a number joining together, and thus being able to provide the sum that an individual small company could not.

I rose especially to refer to the observations of our friend Mr. Tooms. His remarks were full of interest; but I could not quite understand the very strong expressions which he used with regard to the unsuitability of this particular scheme in comparison with the one with which he is so much enamoured, and, I think, rightly enamoured. You must remember that there was nothing of the sort in London when this idea was first entertained. I know I have expressed here in the course of this meeting—I do not remember exactly when—that it was grossly unfair to the consumers of gas that they should be held responsible practically for the training of our servants. I pointed out how unfair it was that we should send inexperienced men to do work on the consumers' premises which they were not sufficiently acquainted with, and consequently allow them to learn their business at the cost of the consumers. I was entirely responsible for the application to the educational authority to let us have these boys. I also inaugurated the idea of erecting the training shop at the gas-works; and I do not think that we have lost sight of the human side of this training work. The boys have every facility for going on three afternoons of the week, I think it is, to the Technical School in Vincent Square, which is quite close to the Horseferry Road. The education provided for them there is very much on the lines laid down by Mr. Tooms; but, at any rate, I am quite content that the scheme should be judged on its merits. The results, as reported by the leading fitters in the district, are eminently satisfactory, and the youths who have been turned out have proved a very great improvement on those whom we were able to get prior to the experiment. With regard to the wages, the amount that may be earned by a youth when he reaches twenty years of age is something like 20s. a week. He may reach these wages before attaining twenty years. I think that Lancashire and Yorkshire will be able to adopt a scheme of wages suitable to the prevailing wages in the district. We are governed here by the rates obtaining among boys of this class; and no doubt in Lancashire and Yorkshire the rates will be somewhat higher.

Reply to the Discussion.

Mr. GOODENOUGH: I have first of all to say how much I appreciate the very kindly way in which my paper has been criticized; and I have to thank you, Sir, for having dealt with one or two points that have been raised, especially by Mr. Tooms. I really could not see, as I listened to Mr. Tooms, where the particular difference lay between the two years' training at a preparatory school and the early training of the lads when taken on under the scheme that has been laid before you. The scheme practically provides for training at a preparatory school specially designed for the gas-fitting trade, and is therefore, if anything, more suited to its work than a trade preparatory school that is not quite so directly connected with the industry concerned.

I think Mr. Morton Fyffe, in his very interesting contribution to the discussion, rather misunderstood me if he thought that I did not attach sufficient importance to elementary education. It was because I attached the very greatest importance to the laying of the foundation that I criticized our present scheme of elementary education; for in my opinion, it has a tendency to let a boy leave school tired of learning, because the attempt is made to cram him

with too much knowledge, instead of giving him more education in the true sense of the word. I am fully in agreement with Mr. Morton Fyffe that much that is learnt at school may never be applicable to the particular walk in life that is subsequently followed; but it may be of the very greatest value to the man in both the earning of his livelihood and the living of his life. For instance, the training in Euclid at school is to my mind one of the greatest advantages that a boy can have, because it trains in him the logical faculty. He may never have to work out the fifth proposition of Euclid from the day he learns it to the day of his death; but the fact that he has acquired the power of arguing out a proposition will be of use to him every day of his business career. I quite agree with Mr. Morton Fyffe that it is desirable that the industry should pay for quality. They will not get quality if they do not pay for it. That is a law of life. With regard to the difficulties of purely local labour with reference to my suggestion as to centralized schemes, surely this difficulty will be got over by the fact that the localities will be able to put it to their councils that they should send their boys to these centres, and that they will get back fitters. You will still employ your local labour; and you will only have sent it away to be put into shape, so that it may be of much greater value to you.

Both Mr. Halkett and Mr. Kendrick have referred to the opposition of the local plumbers to any such schemes as these, and also to undertakings taking upon themselves to do work for their consumers. I hope that this opposition will not be allowed to stand in the way of the progress of the industry. If local plumbers had had their way, no gas-cookers or gas-fires would ever have been hired-out to the consumers. Such a retrograde policy does not need to be discussed by those who have the handling of the gas industry. Mr. Halkett made the very wise remark that the best men that we now get are men of practical experience who educate themselves. It is probably the best that we can get at the present moment; but it is not the best that could be got, because the man who only learns the practical side of the trade when he is young, and then in later life realizes the necessity for more education and sets himself by strenuous effort to attain it, will very rarely achieve the results that he would have achieved if he had had a training from his earliest youth up in the more advanced branches of knowledge that he wishes he had acquired when he comes to take up positions of responsibility. It is a very serious drawback to a man of 35 or 40 years of age, who wants to take up a position of greater responsibility in an undertaking, to find that he has never acquired the power of writing a report or a letter that will stand criticism by anyone who understands English.

I feel with the President that possibly the reason why Mr. Tooms said I had made no attempt to deal with the question of the smaller undertakings, was that my paper was of such inordinate length that he did not get to the end of it. I quite sympathize with him in this respect. I think if he had got to the last paragraphs, he would have found that suggestions dealing with the smaller undertakings were there made.

Mr. Herring called attention to one omission that I made in outlining all that was required in the education of the outdoor representative of an undertaking, and that was the training of him in business psychology—the power of understanding the man with whom he has to do. It has been well said that there are three things you want to know. You want to know your job, you want to know yourself, and you want to know the other man, if you are going to bring about a successful business deal. I quite agree that the training of men to observe and analyze the consumers they are handling is a very important thing. Might I suggest that Mr. Herring should send to the Secretary the notes he has prepared, because I am aware that these notes give particulars which are far more comprehensive than those he has referred to.

When Mr. Kendrick alluded to the question of wages, he mentioned the rate of pay for plumbers. Of course, they are men; and the rates of pay for boys learning their trade could not be at the rate of 9½d. or 10d. an hour. I do not think that this would be suggested even in Lancashire and Yorkshire.

Before sitting down I should like to further express my indebtedness to our President for all the facilities for preparing this paper that I have laid before you, because after all it is his scheme that I have been laying before you to-day. I have only been the instrument to carry out the work which he inaugurated, and in which he has always taken such a very keen interest. I want the members of the Institution to realize that this paper is an account of the service our President has rendered to the industry, and that I am only the instrument to describe it.

Mr. HERRING, complying with a suggestion made to him, sends for publication the following further particulars of his scheme of apprenticeship training of gas-fitters. He says: The plumbers in the Edinburgh district point-blank refused to allow our apprentices to attend their classes, so the Heriot-Watt College organized gas-fitting classes especially for the purpose for them and any who liked to join them.

THE APPRENTICESHIP TRAINING OF GAS-FITTERS IN EDINBURGH.

In 1905 a system of indentured apprenticeship training was inaugurated in Edinburgh with the consent of the Commissioners, and at a later date this received official recognition by the Edinburgh School Board (who, in addition, started a special class in gas lighting appliances), and also the Governors of the Heriot-Watt College (who started a special class in gas-fitting and appliances).

The conditions of apprenticeship are duly set forth as follows: Each applicant must be willing to agree to the following conditions:—

To be legally bound as an apprentice with the Gas Commissioners for five years.

To undergo a medical examination at the Commissioners' expense.

To give an example of his writing and figuring, and to work out several sums in arithmetic—viz., simple multiplication, compound division, simple proportion, and decimal multiplication.

To attend the School Board Evening Continuation classes and the Heriot-Watt or other Technical Colleges as may be arranged during the entire period of the apprenticeship, for building construction and drawing, mathematics, gas-fitting, plumber work, gas manufacture and appliances, the class certificates of which will entitle such apprentice to an additional 6d. per week for the junior and 1s. per week for the senior certificate of any one of the above-mentioned classes after the second year of his apprenticeship, provided the Engineer is satisfied that his conduct, both in working hours and in classes, has been satisfactory.

To agree to the following rates of pay per week:—First year, 7s. 6d.; second year, 10s.; third year, 12s.; fourth year, 16s.; fifth year, 18s. After which promotion to the senior ranks will take place when required, according to merit, irrespective of age or length of service.

[The document would bear the name and address at the end, the signature of the father, or parent or guardian, and the date of signature.]

Questions to be Answered by Lads applying for Engagement as Apprentices in the Gas-Fitting Department.

1.—Father's name.
2.—Address.
3.—Occupation.
4.—Where occupied.
5.—If family, how many.
6.—Boy's (applicant's) name.
7.—Age.
8.—If any previous employment; if so, nature of work, how long, and wages.
9.—Previously or presently employed as.
10.—Where educated.
11.—In what class he was when he left school.
12.—School certificates.

[This document would bear the boy's signature, his address, and the date.]

If these questions are satisfactorily answered, the lads are interviewed, and note taken of their general physical appearance, speech, a test of their eyesight, and the condition of their teeth. They are then submitted to a simple examination in arithmetic, simple and compound multiplication, decimals, and proportion. They are also required to transcribe a paragraph from a daily paper or book. Subject to proficiency in all these, they are started to work for a period of from six to twelve months in one or other of the district show-rooms, from which department they are taken in and passed through a regular *curriculum*, as the exigencies of employment permit; endeavour being made to give the lads the best possible chance of becoming thoroughly efficient in all departments of a gas undertaking's routine in outdoor departments.

Mr. Herring says: Speaking generally, while one cannot express disappointment at the outcome of the scheme, one has found considerable trouble in keeping the lads up to the degree of earnestness which is necessary for them to become proficient. It will be seen that the ordinary rate of apprenticeship pay is greatly exceeded in the Edinburgh terms; the theory underlying this being that a lad of fourteen or fifteen years should, if possible, be earning sufficient to fully maintain himself without assistance from his parents. It

may, however, be remarked that, though there is a premium in the form of an increase in wages for class certificates, I am sorry to say few of the lads have earned such increases; and while I know the scheme is being carried out with the utmost endeavour by Mr. Masterton and his Assistant, a great fault is apparent in the North, as it is seemingly in the London district—viz., want of earnestness in the youth of the rising generation. Another remarkable and somewhat alarming incident is the large number of lads who fail to pass the doctor's examination; so much so, in fact, that the medical examination now takes place before ever the lad enters the first stage of the show-room service.

NOTES ON SUBURBAN GAS SUPPLY.

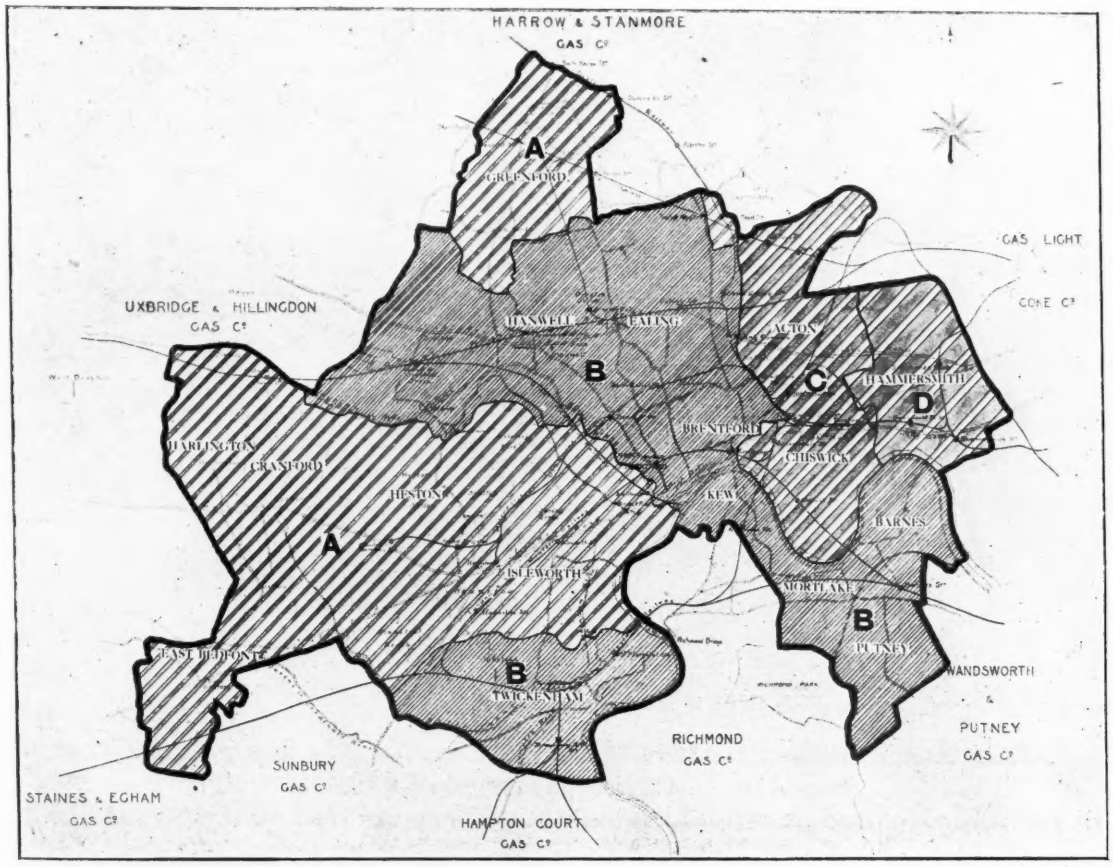
By A. A. JOHNSTON, of Brentford.

The importance of the subject of gas supply to the "suburbs" of the first city of the world will be recognized; and the writer hopes that the few remarks he has to make will prove of some interest to the members. The generally accepted definition of the term "suburb" seems a little incongruous when applied to the environments of London, which in reality consist of a wide belt of important towns having suburbs of their own embracing an ever-increasing area, and becoming more and more populous.

Growth of Suburbia.

Owing largely to the growing facilities for travelling to and from the commercial centre, and to the displacement of one-time residences by premises used for business purposes, the resident population of the City of London proper and its immediate neighbourhood is steadily declining; while that of the outlying "towns" is rapidly increasing. Convincing evidence of this may be found in the Census Returns for 1911, which show that while the population of the City of London now numbers rather less than 20,000, that of what is known as Greater London has reached the enormous total of 7,251,000. In order to illustrate this fact, the writer has prepared a diagram [not reproduced] from the report of the London Traffic Branch of the Board of Trade for the year 1911, which shows very clearly the extent to which the change is taking place.

In addition to the outward movement of population, the diagram also affords an indication of the areas in which



Occupiers per acre: A Under 0·1; B 0·1 to 1; C 1 to 2; D Over 2.

Fig. 1—DISTRIBUTION OF INCREASE OF POPULATION (1901 OVER 1891) IN THE BRENTFORD GAS COMPANY'S DISTRICT.

three quarters of a million newcomers to the Metropolis have been accommodated; and in regard to this, it will be seen that the Brentford Company's district—to which these notes more particularly apply—has been favoured with its full proportion. Figs. 1 and 2 illustrate this point.

The Brentford Gas Company's Area.

The Brentford district embraces an area of about 50 square miles. It includes one borough of over 121,000 inhabitants (referred to in the Brentford Gas Act of 1858 as a village); two towns, each having a population of about 60,000; seven urban districts with populations varying between 16,000 and 43,000; besides a number of smaller districts. The rapidity of development may be gathered from the figures [next page] computed from the Census Return; and to give an idea of the relative progress made in gas supply during the same period, the number of consumers and the annual sales have been added.

Some of these figures are instructive, more especially those showing the percentage of families or households consuming gas; and much might be said with regard to the vigorous policy of the Company who have enabled and encouraged over 90 per cent. of the population to make use of their commodity. The introduction of the automatic meter has, of course, contributed largely to this result; and although the average return from these meters is considerably less than from the ordinary type, a solid foundation has been laid for future development.

In a district such as this, with a population increasing by some 126,000 in ten years, and a yearly output showing

Brentford District.	1891.	1901.	Increase in Ten Years.	1911.	Increase in Ten Years.
			Per Cent.		Per Cent.
Population	259,677	330,689	27·3	456,440	38·0
Number of families .	54,099	71,165	31·5	102,304	43·7
Number of persons per family	4·80	4·64	..	4·46	..
Number of consumers.	16,869	42,817	153·8	91,362	113·4
* Percentage of families supplied with gas .	31·18 millions.	60·16 millions.	..	90·89 millions.	..
Gas sold	1,119	1,848	65·1	2,933	58·6

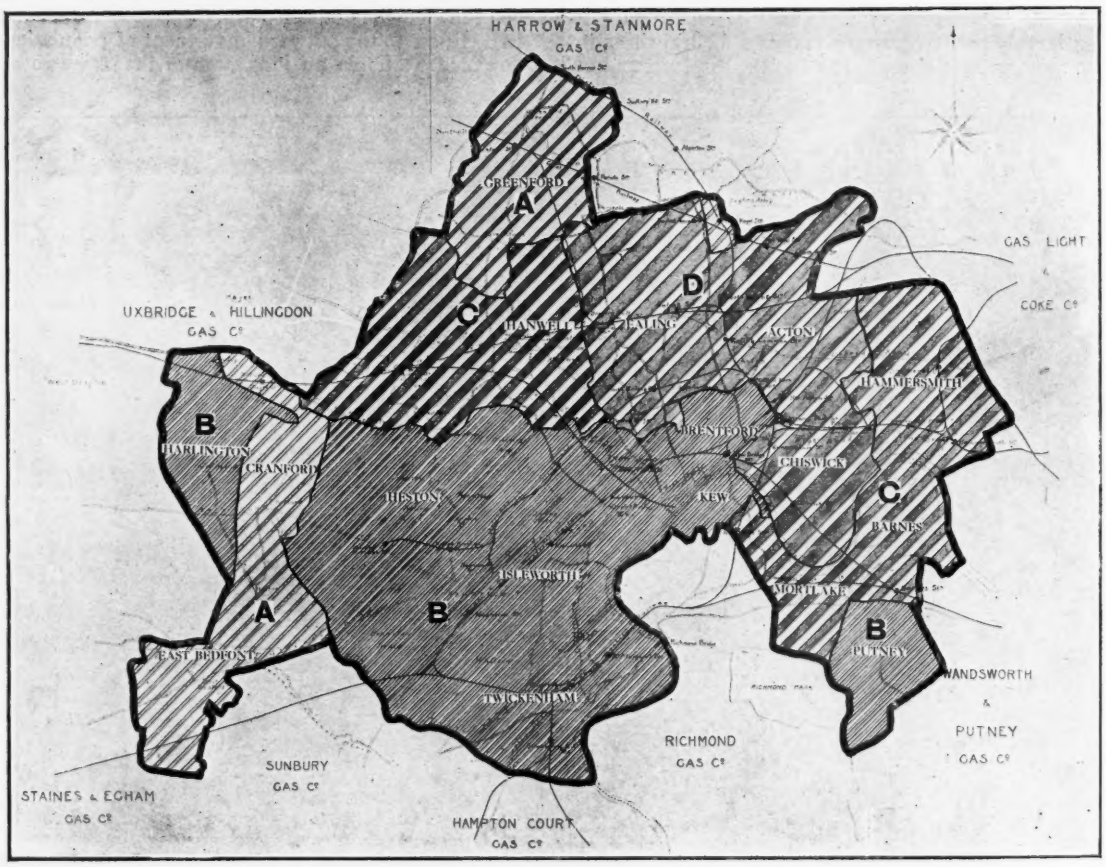
	1913.
Number of consumers	102,662
Number of cookers on hire	80,806
Percentage of consumers using hired cookers	78·71
Number of fires and heating appliances on hire . . .	20,505

* In arriving at these percentages, lock-up shops, factories, &c., having no permanent residents, have been included in the number of consumers; but the Brentford district, being almost entirely residential, the number is small, and would have little effect upon the results shown.

an increase of over 1000 millions in the same period, it is very necessary to look well ahead; and in dealing with some of the means taken to meet the growing demand, the writer hopes he will not unduly tax the patience of the members. To avoid this, no attempt will be made to go into matters directly referring to manufacture, but rather to touch upon points of interest more especially connected with distribution. A plan has been prepared (fig. 3) showing the positions of the two manufacturing stations of the Company at Brentford and Southall, the trunk mains, boosting stations, depôts, and show-rooms.

Distribution.

One of the first problems confronting the writer on going to Brentford in the year 1907, was the inadequacy of the distributing plant; and steps were taken to improve the conditions then prevailing. Owing to the comparative smallness of the mains, and the distance of the works from the larger centres of consumption, the effective capacity of the holders during the period of heavy loads was much reduced, and capable of maintaining the maximum pressure for only a few hours. To add to the difficulty, five of the six governors at Brentford were small, and serving mains



Occupiers per acre: **A** Under 0·1; **B** 0·1 to 1; **C** 1 to 2; **D** Over 2.

Fig. 3—DISTRIBUTION OF INCREASE OF POPULATION (1911 OVER 1901) IN THE BRENTFORD GAS COMPANY'S DISTRICT.

of considerably greater capacity than that for which they were designed. These governors were of a very early type, made by William Sugg in or about the year 1859, and, apart from their size, were still perfectly satisfactory in every respect.

In 1880, a 36-inch main had been laid for the Hammersmith district, and a governor of equal capacity installed at some distance from the original governor-house. There were two station meters, one in the old governor house and one on another site. The controlling valves of the holders were operated from the holder wells. Some of them were in almost inaccessible positions, 10 or 12 feet below ground level; and, taken altogether, the duties of the man in charge of the meters, holders, valves, and governors, were of a somewhat precarious character.

The plan adopted by the writer was to set about the work of concentrating the various governors, meters, and holder valves into one building, so that the man on duty might be able to perform his work under favourable conditions and without risk of mishap, which, as may readily be supposed, was ever-present under the old system. The only available site for the new valve and governor house was that occupied by the 36-inch Hammersmith governor and the show-rooms. The latter was therefore transferred to an adjacent building. It is unnecessary perhaps to describe in detail the progress of the work in rearranging the mains, connections, &c.; but the members will fully appreciate the enormous amount of work entailed in the conversion of the old system to the new arrangement as shown in fig. 5—the manufacture and supply of gas from these works being carried on as usual, and practically without interruption.

The work of conversion was commenced Feb. 11, 1909, and the final connection was made, and the work completed on the 14th of December the same year—a period of ten months. Referring to fig. 4, it will be seen that the coal-gas meter is at one end of the house and the carburetted water-gas meter at the other. The holder valves are now in duplicate, new valves in convenient positions having been fixed on the inlet and outlet connections at the holder wells; the duplicates being placed in the valve-house and

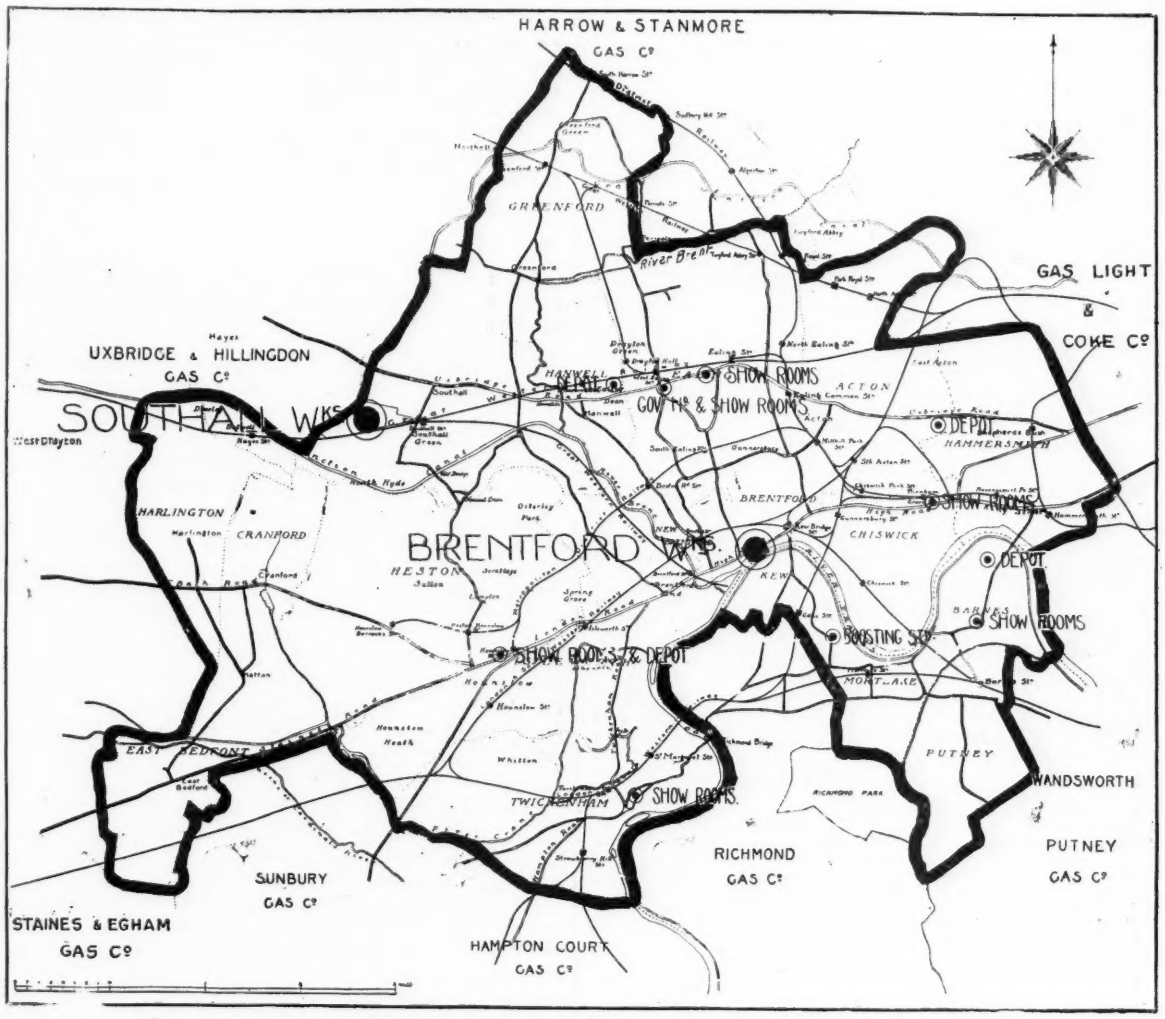


Fig. 3—MAP SHOWING THE WORKS, DEPOTS, &c., IN THE BRENTFORD GAS COMPANY'S DISTRICT.

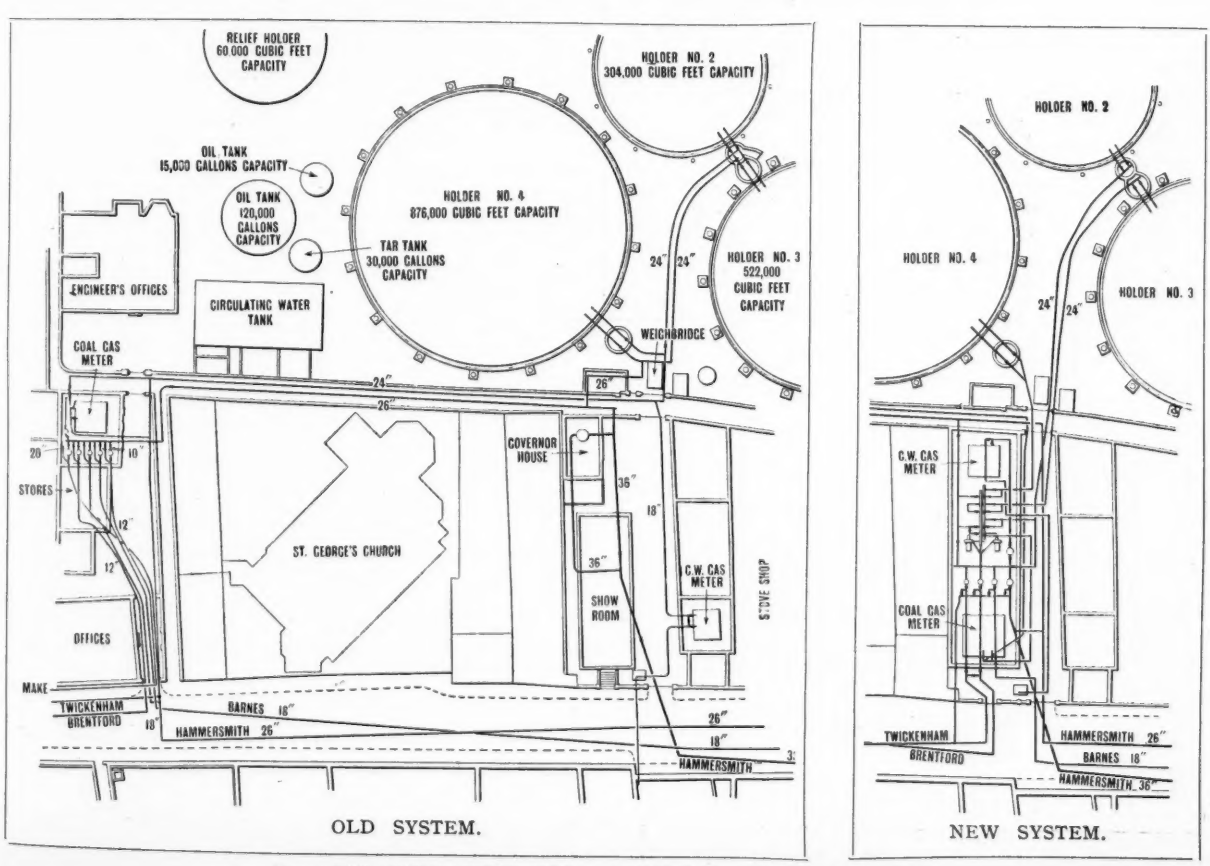


Fig. 4—THE STATION GOVERNORS, &c., AT THE BRENTFORD GAS-WORKS.

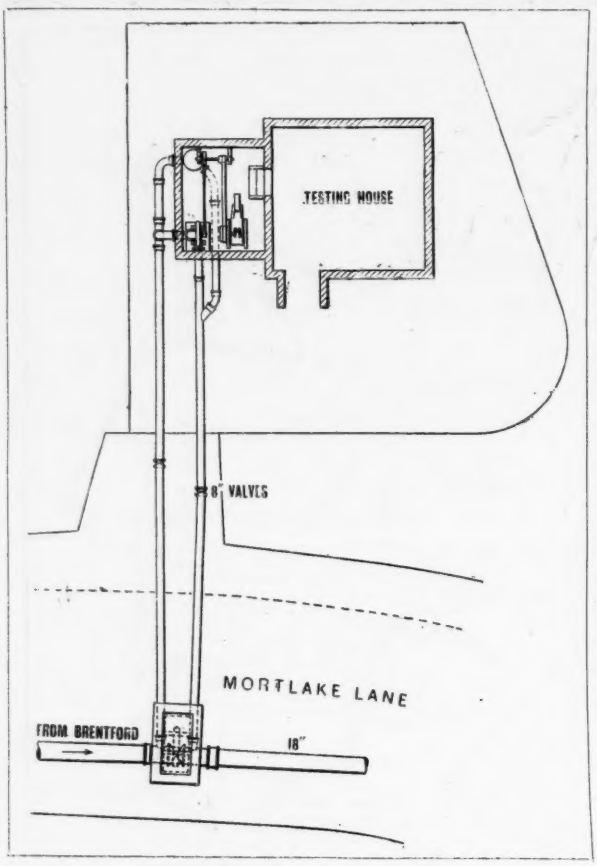


Fig. 5—The "Boosting" Plant at Mortlake.

attached to the "Inlet of Holder" and "Outlet of Holder" boxes.

District Governors.

There are four district governors of the Braddock type, water-loaded and counterbalanced. The governor by-passes are arranged in a manner similar to that employed by Mr. William King at the Grafton Street works, Liverpool—consisting of parabolic valves attached to branches from a main running across the house on the district side of the governors. These valves, which were originally designed by Mr. King, are capable of the most delicate adjustment, and may be used to the full capacity of the mains. In addition to the ordinary water-gauges fixed to the columns of the governors, there are twenty-four hour registering gauges—one to each district. There is also a battery of gauges fixed to one of the walls, so that the pressure at all important points may be seen at a glance, and a check kept on the isolated gauges.

In view of the growing difficulty experienced in maintaining pressure, and in making full use of the holders, pressure-raising apparatus is also installed, consisting of a Sturtevant fan driven by a De Laval steam-turbine. The connections are so arranged that the machine can be used in a number of ways. Gas can be taken from either inlet or outlet of any of the holders, or from the main connecting Southall with Brentford, and passed through governors to the district. It can also be pumped from holder to holder, and driven to, or taken from, Southall, as desired.

The command obtained over the storage and distributing plant is almost perfect, and at the same time another very valuable result has been achieved. The holder capacity for practical purposes has been nearly doubled by the adoption of this system; and it is now possible to maintain pressure "to the last rivet," should occasion arise. This is a matter of the first importance at Brentford, and one that can scarcely be over-rated. At these works (which are the controlling factor in the distributing system), the storage capacity is relatively small, and no site is available for the construction of additional holders.

Intercommunication.

Effective intercommunication between the two manufacturing stations of the Company has been established by means of a 30-inch connecting main—thus enabling the larger station at Southall to supply gas for distribution from Brentford, or *vice versâ*. Without the pressure-raising apparatus, however, the relief afforded would have been comparatively slight, and the construction of another holder necessary. The installation of this plant has therefore effected the postponement of heavy capital expenditure for some years, and thereby benefited both consumers of gas and holders of stock.

Valve and Governor House.

A word may not be out of place with regard to the construction of the Brentford valve and governor house, which was designed and entirely constructed by the staff on the works. The site, which is on a slope, was cleared to the lower level, trenched for foundations, and ultimately covered by a concrete floor upon which the mains, &c., were placed. Concrete retaining walls were carried to the ground level, on the higher and sloping sides; apertures being left for pipes where necessary.

From the ground level the walls are made of hollow concrete blocks, which were made on the works from pan breeze, clinker, and cement. The upper floor, from which the valves are operated, is of open chequered cast-iron plates supported on joists and columns. This floor has the great advantage of admitting light to the lower level, affords a ready means for the escape of leakage, and facilitates its detection. The meter foundations, which are brought to the level of the upper floor, are of differing construction; one meter being carried on brick arches, and the other on a ferro-concrete structure, which allows of easy access to the mains, &c., beneath.

Main Difficulties.

Another serious difficulty met with in a rapidly-growing

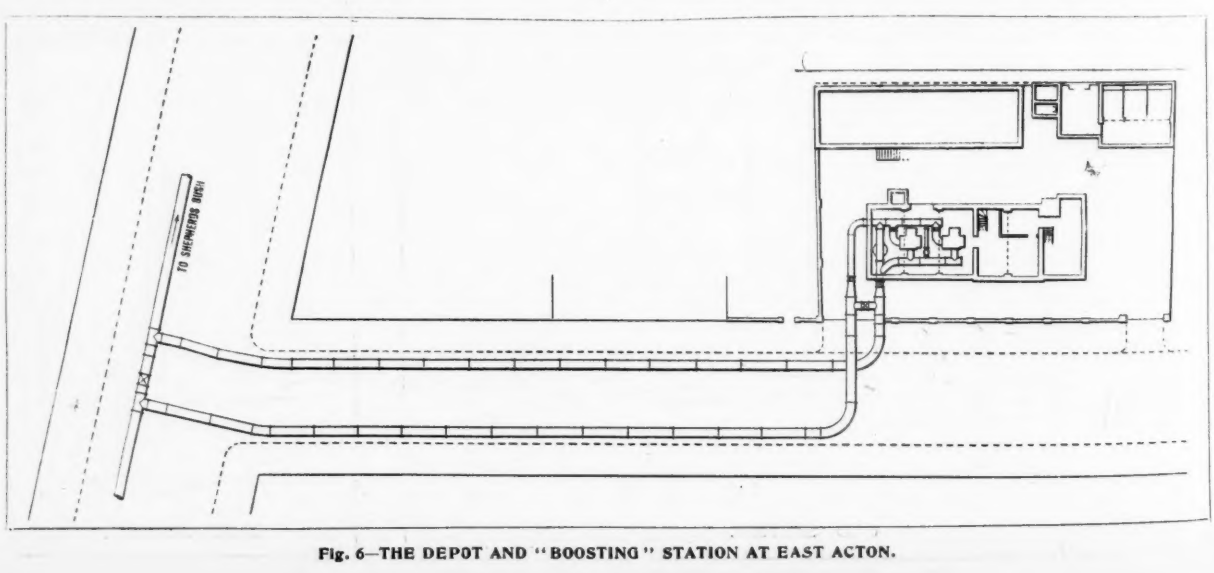


Fig. 6—THE DEPOT AND "BOOSTING" STATION AT EAST ACTON.

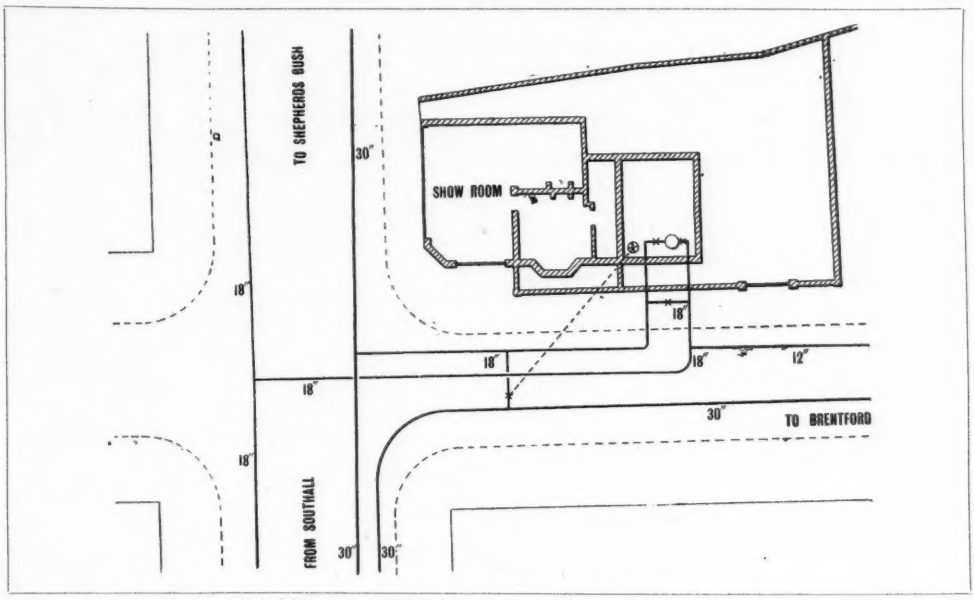


Fig. 7—THE WEST EALING GOVERNOR-HOUSE.

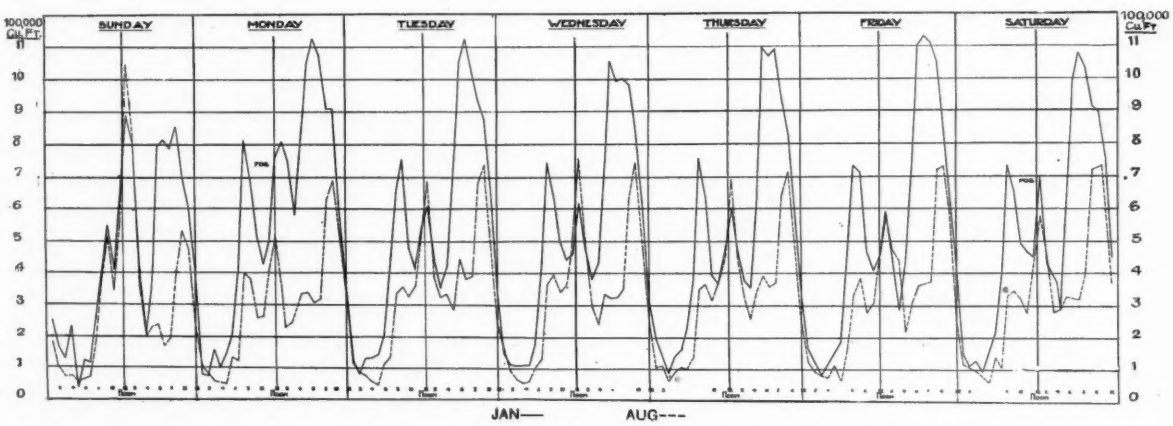


Fig. 8—HOURLY CONSUMPTION DURING THE WEEKS ENDING AUG. 3, 1912, AND JAN. 18, 1913.

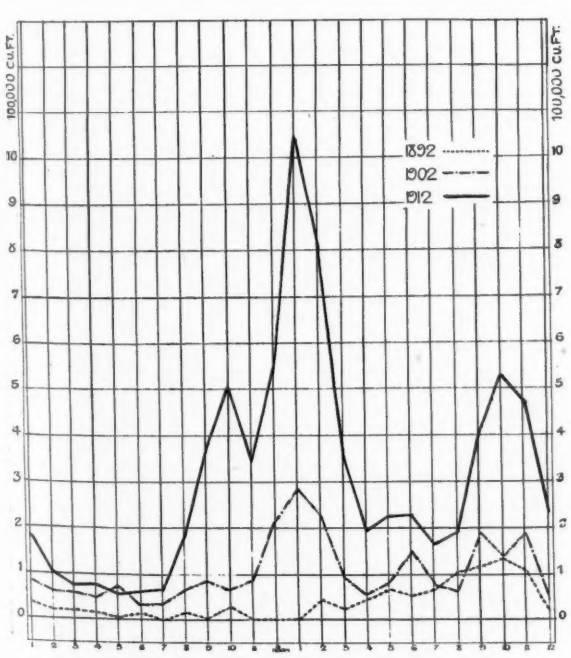


Fig. 9—Hourly Consumptions on the last Sundays in July 1892, 1902, and 1912.

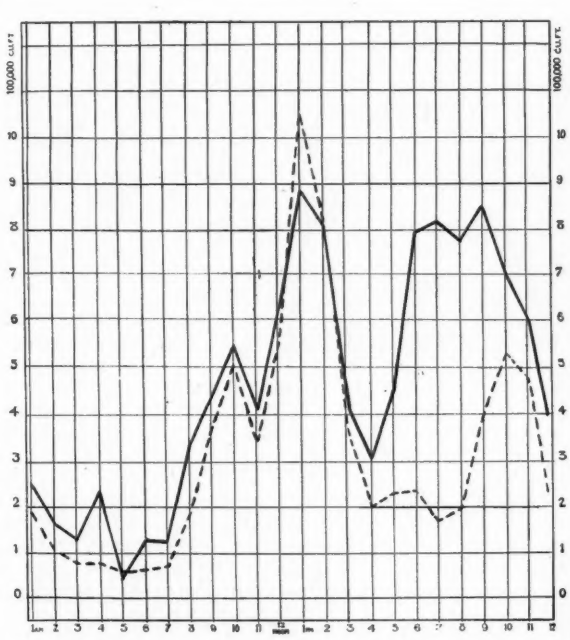
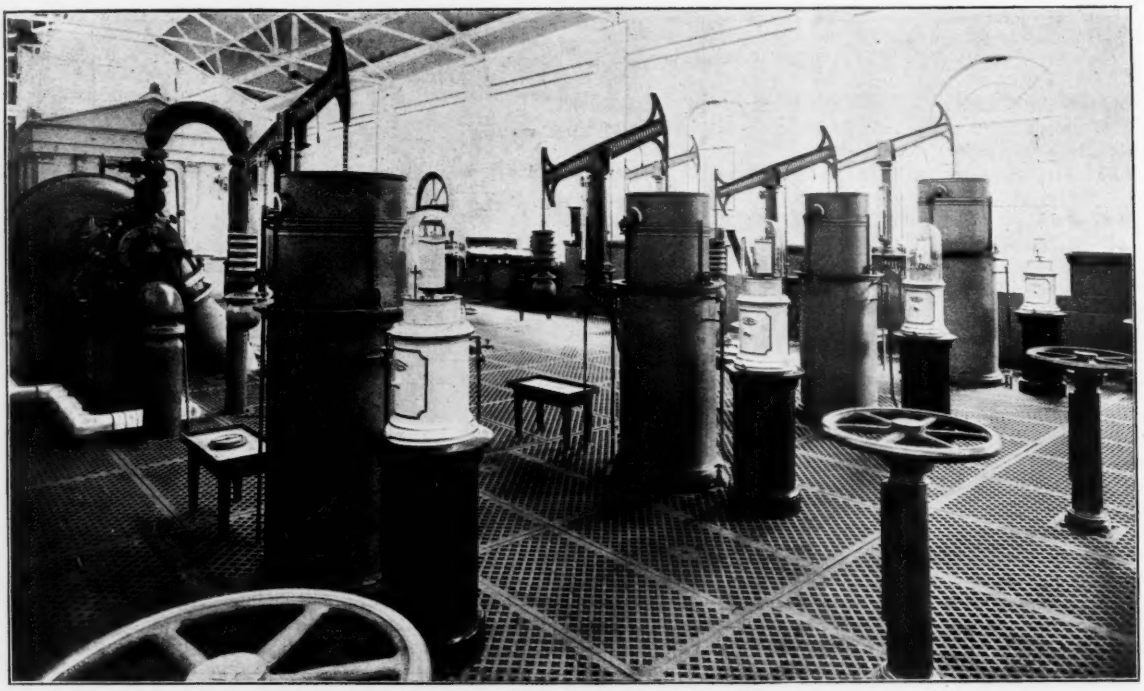


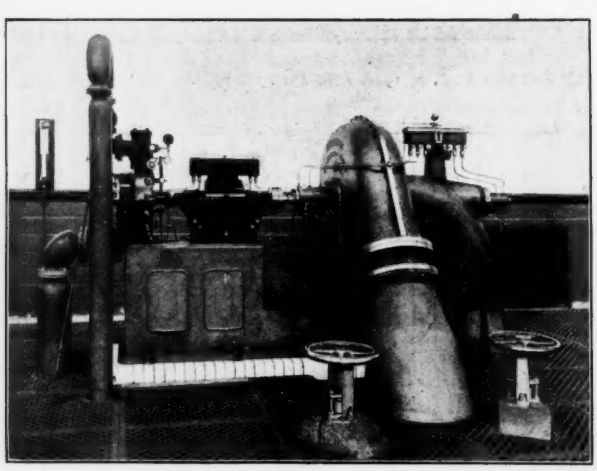
Fig. 10—Hourly Consumptions on Sunday July 28, 1912 [dotted line], and Sunday, Jan. 12, 1913.

district lies in the ever-decreasing proportionate capacity of the distributing mains; and in deciding upon new ones much money may be lost or saved. In these days of expensive road reinstatement and congestion of space available, it is not sufficient alone to consider the present need or even that of the immediate future, but an eye must be given to the probable requirements many years hence. It requires some courage and sacrifice to lay a large main



THE VALVE, GOVERNOR, AND "BOOSTER" ROOM AT BRENTFORD.

where perhaps a much smaller one would be sufficient for the moment. But every day increases the difficulties to be encountered; and seeming extravagance in laying new mains will sooner or later be justified. There are certain roads within the Brentford area where the laying of another main is a physical impossibility, except by means of a tunnel, and that at a considerable depth. Gas and water mains, tram tracks, telephone, telegraph, and lighting cables, surface-water drains and sewers, have all to be accommodated; and the exercise of foresight in this regard becomes more and more imperative.



The "Booster" Plant.

Boosting.

In considering the question of how to meet increasing demands for gas, in so far as mains are concerned, and when the existing mains are deficient in size, there are two courses open—viz., either to lay additional trunk mains, or to increase the capacity of the old mains by means of "boosters" placed at convenient points along the line of route. In districts that are already congested, the laying of a new main entails heavy capital expenditure, often out of all proportion to the revenue to be derived from the increased volume of gas required; and in cases such as this the latter course may be adopted with the greatest advantage.

In many instances it is only during periods of heaviest consumption that trouble is met with, lasting but a few hours at a time perhaps, during the winter, and for an hour or so on Sunday during the summer. A "booster" is then invaluable, enabling an increased volume of gas to be conveyed by the main without unduly raising the initial pressure at the works. The gas is "assisted" along by reducing the pressure a little on the inlet side of the booster, and raising it on the outlet or forward side. As the writer has already pointed out, the advantage consists in the ability thereby obtained to increase the effective carrying power during the hours of heaviest consumption at comparatively small cost. This method has been employed at Brentford with excellent results, and attention is drawn to fig. 5, which shows the arrangement used at Mortlake, on the trunk main conveying gas from Brentford to Barnes, Roehampton, and Putney. Prior to the installation of this plant, the pressure in parts of the area served was indifferent. But since its introduction, control has been regained; and, notwithstanding extensive building operations in the neighbourhood, any cause for complaint on this score has ceased to exist.

The Twickenham Show-Rooms of the Brentford Gas Company.

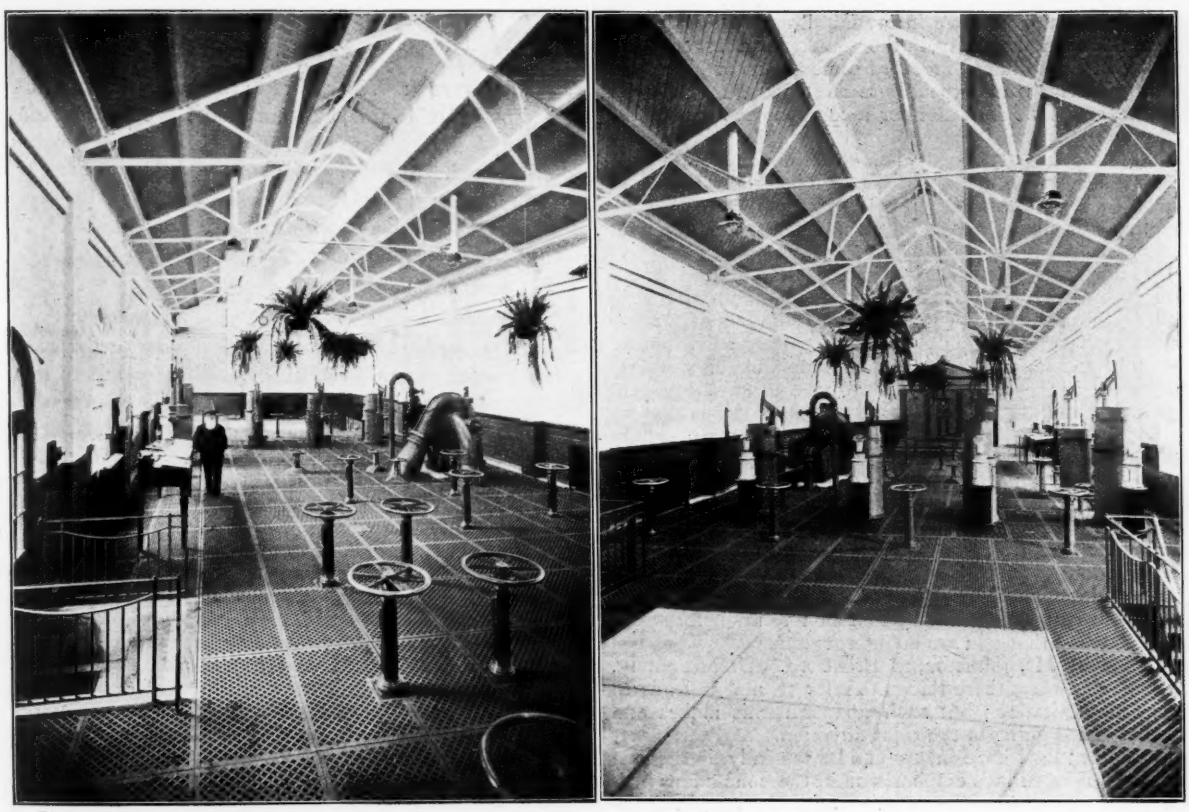
Encouraged by the successful application of this principle, more modern and elaborate plant has been fixed on the line of main serving the important district of Hammersmith. Fig. 6 shows the system installed at East Acton, consisting of Rateau fans driven by Gardner gas-engines in

duplicate. The main in question serves a very large and important area; the bulk of the gas being consumed in Shepherd's Bush, at the extremity of the main furthest from the source of supply—a distance of 8 miles. Before reaching this point, the main passes through Southall, Hanwell, Ealing, and Acton; each of these populous centres taking its quota of gas on the line of route.

The main connecting the Southall works with Brentford, runs parallel with the district main for a distance of 3½ miles, and contains gas under considerably higher pressure. Advantage is taken of this to reinforce the latter at West Ealing, where the course of the two mains diverges, and a connection is made between the two through which gas is fed into the district main during periods of heavy consumption. Fig. 7 shows the district governor house in West Ealing, at which point the connection is made, and a Cowan water-loaded governor is fixed to control the service mains for the supply to Ealing. The valve for controlling the interchange is operated from the interior of the governor house.

From this point, little or no gas is distributed from the district trunk main until it reaches the boundaries of Acton, where it is again called upon to supply a large population. This, of course, has the effect of considerably reducing the pressure, and by the time the main reaches the eastern boundary marked diminution is shown. Beyond this point lies a crowded area, still further taxing the capacity of the main and increasing the difficulty.

The boosting plant already mentioned (see fig. 6) was therefore installed at East Acton; and although it is not necessary to bring it into operation during the summer months, the value of the plant will be greatly appreciated in the Shepherd's Bush and Hammersmith districts during the heavier demands of winter. Bearing upon this point, an interesting diagram (fig. 8) has been prepared, showing the hourly consumption of gas during a week in the past winter, as compared with a week in the previous summer. A study of the line representing the volume of gas consumed during the summer week, when in the hours of daylight it may be assumed that there is very little gas used for purely illuminating purposes, will give a close approximation of the times when the majority of people take their breakfast, mid-day meal, and tea, and an indication, too, of the comparatively short periods of maximum demand. Attention



OTHER VIEWS OF THE GOVERNOR ROOM AT THE BRENTFORD GAS-WORKS.

is also directed to the influence of foggy weather on the consumption during the winter week, when lamps and burners were in use.

Diagrams Nos. 9 and 10 may also prove interesting, fig. 9 showing the hourly consumption of gas on the last Sunday in July, 1892, 1902, and 1912, and fig. 10 the consumption of gas on a Sunday in mid-winter last against a Sunday in midsummer last. These diagrams illustrate very clearly the advances made in cooking by gas.

Before leaving the subject, the writer would like to emphasize the considerable advantages he has found, so far as the administration of the district is concerned, of decentralizing the outdoor staff, which not only results in greater economy in working, but enables the staff to deal with the consumers' needs more expeditiously and efficiently—thereby better serving the interests of both the supplier and user. Depôts are established on the Brentford district in the localities most suitable for this purpose. In most cases, the show-rooms, depôts, compressors, &c., are on the same site. The buildings erected at Hanwell, which include a pair of cottages occupied by district foremen, are entirely constructed of concrete blocks, in the same way as before described in reference to the valve and governor house at Brentford.

To refer to the numberless works of reconstruction carried out in other directions would demand more time than is at the writer's disposal; and if the members have been interested in only a small degree, the purpose for which these few notes were written will have been achieved.

DISCUSSION.

Mr. R. W. Edwards (Aldershot): The paper that has just been read is one which appeals to me very deeply, inasmuch as there are many points which are on similar lines to those on which I have been working for the past ten or twelve years. I find that Mr. Johnston's circumstances are very similar to those which I have had to deal with, only, of course, mine are not on such a great scale as those at Brentford, although proportionately. That is to say, the ratio of difference between the minimum consumption and the maximum is approximately the same. In my case, I have a large centralized manufacturing station, from which gas is distributed to the home districts, and also

transmitted by high pressure from this station to distributing stations some 4½ miles away, and thence from the distributing station by various feeder mains to outlying areas. In these outlying areas there are several compressor stations; the object of the compressor stations being to raise the pressure of the gas to such a point that it is acceptable to the consumer. For instance, we have taken over some two or three small companies; and, in addition to these small companies, we have incorporated districts beyond those areas. With a view to making use of the small mains within these companies' districts, a larger main was laid from the distributing station right through, and the small distributing mains coupled to the main artery; and, instead of putting in a district governor, these small mains were used for high-pressure purposes, and on each service at the inlet to the meter a service-governor was fixed. We found that this enabled us to utilize the small mains, after making them tight, for the higher pressure, and, at the same time, would give the consumers an efficient supply of gas which they would not have got if we had not put in either new mains or in some other way increased the pressure. Then, in addition to dealing with districts like these, we have had such cases as those on which Mr. Johnston lays emphasis in his paper—namely, where we have put off the laying of a larger main. I have in my mind one particular case where there was necessity, in the winter, for a larger feeder main which would have involved some £4000 or £5000 expenditure. Such an expenditure as this, you can quite imagine, is a serious matter for a company the size of the Aldershot one; and I decided to put down a small pressure raiser, at a cost of £200. This met the difficulty, and postponed the laying of the new main for four or five years; so that, by a simple calculation, you will readily see that, by adopting this course, considerable saving was effected over that time.

I do not know whether Mr. Johnston has noticed it, but there is one peculiarity that I have noticed, and that is in sending the gas, by high pressure, from the manufacturing station to the other station 4½ miles away, and re-distributing from this station, we rarely get any complaints of naphthalene, while in the home district we have the usual percentage of complaints. My only explanation of this is that we do find in the syphons of the high-pressure main certain deposits which are undoubtedly naphthalene deposits. It gives one a great deal of comfort to have such a paper as this to go back to, because when one has to do these things from time to time, without having the pleasure of knowing that larger undertakings are doing something similar, it certainly does give one confidence when one hears, from a paper of this description, that in initiating things of this nature you can have some information to lay before your board showing that you are doing something like what has been done by Mr. Johnston, at Brentford. Unfortunately, one has not always these things to refer to, and it leads to some little hesitation; but such a paper as this makes one feel that one is going in the right direction.

The point that I have in my mind, especially, is the one that Mr. Johnston lays emphasis on in the concluding portion of his paper, where he says: "Before leaving the subject, the writer would like to emphasize the considerable advantages he has found, so far as the administration of the district is concerned, of decentralizing the outdoor staff." Some seven or eight years ago, I decided on a very similar course, and to-day, over the statutory district, comprising 135,000 acres, we have 33 parishes; and these parishes have been divided into six groups. Each group is in the charge of a district inspector, with a local office and showrooms; and the six district inspectors come under the control of an outside superintendent. I can assure you that our experience has been very satisfactory. Not only does it relieve the chief office of complaints appertaining to these outside districts, but it enables us to give prompter and more direct supervision to the complaints and needs of the consumers in the isolated areas, which it would take some time to get to, if we had to send a fitter ten or fifteen miles to the job. Therefore, you will see that I feel very much comforted indeed to think that we are, in a small way, working on similar lines to those adopted by such an enterprising company as that of Brentford.

There is just one other point that I should like to ask Mr. Johnston about. It is this. I observe that his compressors are of the fan type. In my case, all the compressors I have put down are of the positive type, as I prefer them for the raising of the pressure to such an extent as we find to be necessary.

Mr. Walter Hole (Leeds): I think it would very materially increase the value of this paper if Mr. Johnston could give us some further figures. Taking the case of the Mortlake plant, could he give us the exact pressure at the particular point where this plant was installed, before the plant was installed, and the pressure on the inlet and outlet of the compressor when the compressor is at work? Also whether any consumers are fed from the 18-inch main, within (say) 300 or 400 yards of the inlet to the compressor; and, if so, whether any trouble has been experienced with these consumers when the compressor is at work.

Mr. Edward Allen (Liverpool): All I have to say is that the paper which Mr. Johnston has given to us is of great value. He has dealt with the problem which has faced many of us, and that is how to adapt old works to new conditions. I want to say, on your behalf, how much we appreciate the amount of work which he has put into his paper, short as it is, and the very excellent cartoons with which he has illustrated the paper. I am sure it will be of very great value to the Institution; and I would not like him to think that, because the discussion has been so short, therefore we fail to appreciate the value of it.

Reply to the Discussion.

Mr. Johnston: With regard to the points that have been raised by Mr. Edwards, I do not think the conditions under which he is working are quite the same as those obtaining at Brentford. We are merely using the ordinary low-pressure mains, and increasing their capacity; whereas Mr. Edwards has made a high-pressure main of the whole length and fitted governors.

Mr. Edwards: We have done both.

Mr. Johnston: I am sorry if I have misunderstood you; but the probabilities are that you raise your pressures to a much greater extent than we do. With regard to naphthalene, we have found no difference. We get very little naphthalene in any case, and certainly there has been no change owing to boosting. I have already said that the compressors used are of the fan type; and we find them quite sufficient for the purposes named. In answer to Mr. Hole's question with regard to pressure. At Mortlake, for instance, there are no consumers within 300 or 400 yards of the mains. We take gas from the main before ever it reaches Mortlake, at some little distance away; and on the outlet side there is quite half-a-mile before we meet another consumer. With regard to the difference in pressure, I find the pressure at Mortlake would be about 4½ inches under normal circumstances. By means of the booster, we lower it on the inlet side to 3½ inches, and put it up to 5½ or 6 inches, as occasion requires. I think I have now answered all the questions that have been put to me.

VENTILATION AND GAS.

By S. B. LANGLANDS, of Glasgow.

In October last Professor V. B. Lewes reviewed the subject of gas from a hygienic standpoint before the British Commercial Gas Association, and he very ably showed the great importance of the question of ventilation. It was this lecture, so full of suggestive thought, that turned the author's attention to the subject; and a kindly word of encouragement from Professor Lewes himself made him persevere in the work he is now about to describe.

The usual method of ventilation at the present day is by means of open windows or apertures in the roofs, ceilings, and walls of buildings, through which the vitiated air of the room is allowed to pass, or is forced through to the outer air by mechanical means. Even with the best system invented, having this as the root idea, draughts cannot be avoided. Some new plan on which to design our ventilating systems must be evolved, in which we must not, while having our hearts' desire of a sweet, wholesome atmosphere, have to submit ourselves to contracted currents of air.

The first scheme which naturally suggests itself is that of increasing the size of the apertures. But the author's idea

is more than this; it is to enlarge the aperture to the size of the ceiling itself and to continue it on to the walls, if needs be. In other words, his idea is to have a porous ceiling, and perhaps a porous wall to the depth of a foot or so from the ceiling, so that the hot vitiated air may percolate through them with sufficient speed to keep the air in the room sweet and wholesome. The speed of the air would depend on the use to which the room was to be put, and, therefore, different materials, or different thicknesses of the same material, would have to be used according to the requirements of the case. This, then, is the idea the author wishes to bring forward, and he hopes that, with the assistance of the Institution, and perhaps the assistance of such bodies as, say, the Department of Coal Gas and Fuel Industries of the University of Leeds, some further work along the lines suggested will be undertaken, and, eventually, the public generally will be brought to recognize in gas the only hygienic means of heating and lighting.

Considering the details of the proposal, naturally, the first question asked is what material is to be used for the ceiling, and some facetious member may suggest a return to the old style of thatched roofs and no ceilings. Excellent, the author would reply, if non-inflammable straw could be supplied. But he has no information to offer as to any such material.

Some of the author's experiments, which it may be added were interrupted by work of a more pressing nature, may now be referred to. A square wrought-iron box was made, open at bottom and fitted on the top or ceiling with a slab of Kieselguhr, a very porous brick, the chief constituent of which is diatomaceous clay. A bunsen burner was lit inside the box and a little dust scattered on the top of the slab. A beam of light was projected across the top of the box, and the movement of the dust particles was observed, with the object of obtaining an idea of the comparative rates of flow of the gases, not only through different thicknesses of the material, but through other materials as well. It was the author's intention to experiment with other materials, such as perforated lime-washed sheet zinc, lime-washed copper gauze, wood-slatted roofs, unglazed porcelain (of which material the porous part of the Leclanché cell is made) and the ordinary tobacco-pipe clay which was used in the classic experiments of Ramsay and Rayleigh, for the separation of nitrogen and argon. It might even be possible to use a good quality of ashes to answer the double purpose of deadening the sound and of forming the porous ceiling.

This leads to the question—where are the foul gases to go? If there is a room above, it would be necessary to treat the underside of the floor above the porous ceiling to prevent the gases entering the room. This could easily be done by oiled paper or some other impermeable material being laid upon the floor. As to the further progress of the foul air, it would be a mere constructional detail to leave a free passage from between the ceiling and the floor of roof to between the lath and plaster of the wall of the room above, and thence to the roof of the building where, if necessary, artificial means for inducing a flow might be employed. There are many other constructional considerations—such as the clogging of the pores of the material by dust—which would need attention, and it is on these that discussion is desired.

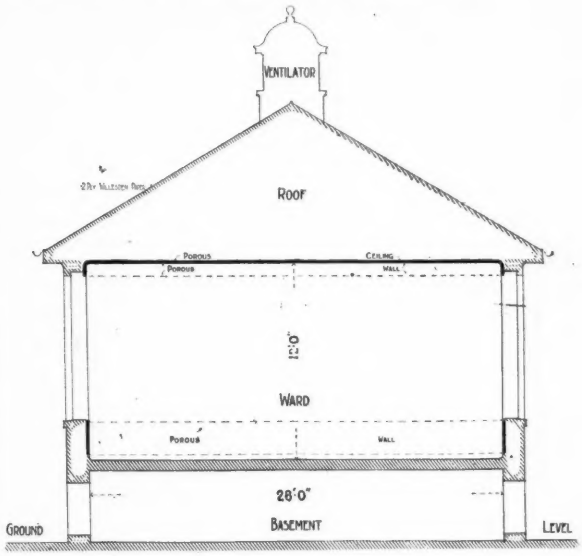
If a schoolroom could be experimented upon, the author believes that valuable results could be obtained. In no place is a good supply of fresh air more to be desired, and it is quite apparent that open-air teaching, a difficult matter, in our uncertain climate, would never be attempted, were it not felt that the hygienic conditions of the schoolroom are not as they should be. Or, again, a hospital ward would be an ideal place in which to carry out experiments. Much time and money have been spent in the endeavour to arrive at a perfect system of ventilation for hospitals, and many commissions have sat and blue books been published on the subject. The accompanying plan illustrates the treatment of a hospital ward suggested by the author.

Finally, it is evident that if air can be taken out of the room through a porous ceiling and porous walls, it can also be quite easily drawn into the room in a similar manner—draughts being avoided in both cases.

This, then, is the scheme suggested by Professor Lewes's lecture, and the author is convinced that the main idea is correct. What he now hopes he may have is a full and free criticism of it, and the co-operation of all interested in considering details of materials to be used, thicknesses required, &c. When the user becomes convinced that the heat contained in the hot gases which pass away from his burner is not so much wasted energy, but serves the most important office of ventilating, gas need have no fear of any rival illuminant.

As this paper may appear crude and unfinished, the author would explain that the only reason he had for submitting it before concluding his tests and experiments was that he understood the Institution had arranged for the appointment of a Committee to consider the whole subject of ventilation in its relation to gas, and he was anxious to have his ideas tested in any research work that might be carried out. He has to thank his assistant, Mr. Littlejohn, for his very valuable help.

In conclusion, the author ventures to suggest the advisability of not in any way restricting the discussion on the paper, but allowing members to discuss the whole question of ventilation in its relation to gas, not confining their remarks to the idea he has submitted. By this means, some useful suggestions for future work may be elicited.



SECTION THROUGH A HOSPITAL WARD.

CALCULATIONS.

INLET.

Area of ward, 80 ft. × 26 ft. = 2080 square feet.
Number of patients, 20.
Allow 3000 cubic feet of air per person per hour;
Therefore 60,000 cubic feet of air is required per hour.
Area of inlet, 200 × 2 = 400 square feet;
Therefore required speed of air per second = $\frac{1}{24}$th part of a foot.

OUTLET.

Effective area of ceiling, one-fourth of 2080 = 520 square feet;
Therefore required speed of air per second = $\frac{1}{30}$th part of a foot.

DEPRECIATION: ESTIMATED AND ACTUAL.

By ALEX. C. HUMPHREYS, M.E., Sc.D., LL.D., of New York.

The American Gas Institute having accepted the gracious invitation of the Institution of Gas Engineers to present a paper at this meeting, which is intended particularly to celebrate its fiftieth anniversary, I have been designated to represent the Sister Society for this service. I appreciate the honour thus conferred; and this sense of appreciation finds emphasis in the fact that my long-time friend, Sir Corbet Woodall, is the Institution's President this Jubilee year.

I have chosen as my subject "Depreciation," so-called. This is a subject of importance to the owners and managers of all industrial properties. It is of particular importance to the owners and managers of public service properties. In connection with rate-making cases before commissions

and courts, it is of vital importance to-day to the owners and managers of public service properties in the United States. Within the limits of a single paper—perhaps extended beyond the bounds suggested by a kindly forbearance—I cannot hope to meet satisfactorily all the many and complex questions which have come to be included or involved in the ambiguous term "Depreciation." Certainly, as used in the United States the term is not self-explanatory. This inability on the part of those discussing moot questions to agree upon the meaning of terms and forms of expression is at all times a fruitful source of otherwise unnecessary disagreement. Perhaps this is particularly in evidence in the United States. I know in advance, therefore, that, through one cause or another, partly on account of the magnitude of the subject and my inability to give adequate expression to my views within the limits required, I shall not now succeed in avoiding all misunderstanding.

Necessarily, what I have to say is of more direct interest to an American audience. But part of what follows should be of interest to all owners and managers of public service properties; and in view of the fact that there is no inconsiderable amount of British capital invested in American public service properties, this discussion may be found to be of direct interest to many on your side of the Atlantic. In view of the spirit of unrest which is now in evidence all over the civilized world, and the readiness with which additional laws are placed upon the Statute Books of the United States, it is of the utmost importance that those who are responsible for these properties should be more nearly in agreement as to the most effective lines to be followed in their honest efforts to secure full protection for the investments entrusted to them.

If the many and complex questions involved in depreciation are to be solved, so as to do justice both to the investor and the purchaser of service, there is required on the part of all concerned the most competent, comprehensive, and judicial study and treatment. While this responsibility must rest upon all who can or do exercise influence in the settlement of these questions, particularly must the responsibility rest upon the lawyers and experts representing the companies. In certain cases these representatives of legitimately invested capital have not sufficiently mastered the questions involved to qualify them to meet effectively their great responsibilities. This is peculiarly a cause for concern because the commissions and courts have of late years had thrust upon them for adjudication many novel questions; and so they need at our hands all that we can furnish as to general theory and special conditions. Here it is necessary for us to distinguish between hypothesis and theory. The theories adopted must include all the accepted teachings of experience.

While looking and hoping for, and confidently expecting, such a revision of public opinion as will give the public service corporations more even-handed justice than has been indicated of late in certain cases, this hope and expectation should rest upon the determination on the part of those most directly concerned to do all that is legitimate and straightforward to this end. Certainly it is the duty as well as the best policy of the representatives of the companies to be frank in their statements of fact, and bold in the presentation of their opinions, provided those opinions have been formed with the rights of all in mind.

We must believe that, in the great majority of cases, the commissions and courts are doing their best, as far as time and training permit, to arrive at just decisions. But without wishing to express disrespect for our commissions and courts, certainly we must not be too ready to accept their opinions as the final word on any technical question. Some of our lawyers and experts are too ready to accept court opinions and decisions as final. The fact that on any of the questions we have to consider we can find court opinions varying through a wide range should furnish a sufficient corrective to this subserviency of mind. Certainly we should constantly keep in mind that, at least on many of the technical questions involved, we engineers are more competent to form a correct judgment than are lawyers or judges.

For instance, I am not prepared to change my opinion as to the strength of cast-iron pipe as ordinarily used for the distribution of gas because the late Justice Peckham, of the Supreme Court of the United States, in handing down the unanimous decision of the Court, in the celebrated New York Consolidated Gas Company's case, included in his opinion the statement that one feature of the law under consideration could not be enforced against the Company because a pressure measured by a column of water 2½ inches high would burst the cast-iron pipes conveying the gas.

This may be taken as an exceptional error. But this case of the Consolidated Gas Company was one of vital importance to our public service corporations, and should have received the most careful attention of the Judge to whom was assigned the duty of making the more specific study of the evidence and of writing the opinion of the Court. Judge Peckham was an able Judge and a fair man, and yet he made an error which an illiterate but specifically trained foreman of a street gang could not have made. If Judge Peckham could make such an error, why should we blindly accept the opinions of commissioners and judges simply by reason of their official position?

Are we not further warned against a too subservient attitude of mind in this connection when we find our commissions and courts holding widely different opinions on what appear to be comparatively simple points of law? Where there is a direct question stated with all the facts arrayed on both sides, I see no reason why the engineer is not as competent to express a sane opinion on the law as a judge or lawyer is competent to express a correct judgment on some technical question in engineering or accounting. I feel quite sure that in many such cases I could do as well on the law questions as Judge Peckham did on the question of the strength of the ordinary cast-iron pipe.

I could cite many other cases to support this proposition. I have in mind a statement presented over the signature of the chief statistician of one of our most influential State Public Service Commissions, in which nearly a million dollars was deducted from the operating expenses of a certain company because the money was paid for taxes. Those of us who have to supply from income the money to meet the tax collector's claim, will find little comfort in the statement of commission or court, that this item of cost is a "fixed charge," and therefore something different from the other items of cost—such as wages, salaries, coal, &c. I do not find that this classification assists me to pay the bill or to reduce the cost per 1000 cubic feet of gas sold.

Much of the error to be found in the opinions and decisions of the commissions and courts is due to the acceptance of hypotheses as theories, which fail to meet the definition of theory because they exclude the necessary limitations of practice. One reason for misunderstanding in connection with depreciation, so-called, is that some of those charged with responsibility fail to appreciate, either wholly or in part, that the questions involved are not the same in the case of a so-called monopoly, subject to governmental regulation, as in the case of a commercial undertaking engaged in an avowedly competitive business, and which has only to reckon in this connection with its owners. This statement is not to be misinterpreted by those who, through ignorance, are ready to discover dishonest motives actuating those dealing with the public.

To take a simple example. In a close corporation engaged in a competitive business, the managers of which are liable only to their own stockholders, it may be considered right and wise to distribute only a portion of the net profits and to apply, wholly or in part, the surplus profits, particularly in extra prosperous years, to writing-down the plant account. In the past this has been regarded as conservative practice. Even though the proprietors received no additional stock to represent the increase in assets, they knew that their proportional shares in the ownership of the property remained unchanged. But to get a fair return on the full investment, the dividends were necessarily based upon what appeared to those uninformed as an excessive dividend rate. The fact that the plant and business had been extended by the investment of earnings—the dividends paid as averages through the years probably having been moderate—does not in any way vitiate the ownership of the stockholders in these extensions. If all the net profits had been distributed to the stockholders, and then the additional capital as required had been handed back to the company in payment for additional stock, the facts would not be changed. Yet by this last method there could have been no question as to the rights of the stockholders.

Now in the case of public service corporations whose rates of charge are subject to regulation, however, this practice raises questions, and so subjects the stockholders to unnecessary hazard. In the State of Massachusetts, this practice of writing-down plant account—charging extensions against income and also debiting lump sums to loss

and gain and crediting plant account—has been much in evidence. This was to be expected from the generally conservative tendencies in New England. The State of Massachusetts was the first to place its gas companies under the supervision or control of a Commission. This Commission was not given the powers that are now conferred upon our State Commissions; but it exercised a very restrictive influence as to stock and bond issues and rates of return, and its decisions in this connection have not been notable for consistency. The case is made harder for the stockholders because the law of this State prohibits stock dividends to cover surplus earned.

The effect of this writing-down of the Massachusetts companies is at once apparent by a study of the annual reports of the Commission of Gas and Electricity. These companies, instead of showing "watered" stock, show a total capitalization which does not represent the structural value of the plants, to say nothing of certain overhead charges and "going value." One of these companies shows a capital which is only equal to 35 c. per 1000 cubic feet of annual sales. If we add to the capital stock as issued the "notes payable" issued to cover *part* of the extensions and for which the company may hope to be allowed to issue stock, the total is only $1.64 cents per 1000 cubic feet of annual sales. The cost to reproduce the plant and business of this company would exceed $5 per 1000 cubic feet of annual sales.

In a case recently decided by this Commission, the gas company involved (Attleboro) had been paying 12 per cent. dividends on a capital which was equal to $1.10 per 1000 cubic feet of annual sales. The Commission in its opinion says: "Its capital, in proportion to its business, ranks lowest of the gas companies in the State." This company had no "notes payable" against extensions; so presumably the Commission took this into account in making the comparison with other companies, and particularly the company to which I first referred. But notwithstanding that the company was paying only 12 per cent. on its capital as issued, which would have been about 2·6 per cent. on a capital equal to $5 per 1000 cubic feet of annual sales, the Commission reduced the price of gas, at the same time enunciating certain rules which clearly must operate to confiscate portions of the company's legitimate investment.

I simply introduce these cases to point out that what may be conservative policy in the matter of writing-down plant account to cover "depreciation" in the case of a company managing its own business, it is a fatal error to write-down assets below their legitimate investment cost where we are subject to the opinions and control of those who have had insufficient practical experience. It may be easy to understand that the public, in the persons of the consumers, are willing to take something for nothing, but this does not prove that the investor can rightfully be required to accede to such a demand; and if he is so treated he will in future be slow to furnish capital for new public service undertakings, or for the further development of those already in operation.

Not only does this unscientific and haphazard method of "writing-down" of assets work a direct injury to the stockholders of the company involved, but it works an indirect, but very potent, injury to the industry as a whole, by furnishing opportunities to the adroit and unscrupulous statisticians to make comparisons which appear convincing on their face, but which have no value when analyzed. Unfortunately many such comparisons are accepted on their face in the absence of competent analysis. Here we must not forget that the public and the irresponsible politicians are on the watch for high rates of dividends, without regard to the relation between total legitimate investment and total face-value of bonds and stock.

It may create some surprise if I make the statement, as I do, that not a few of our well-established steam railroads have so maintained and so extended and bettered their plants from income that they could not now pay 5 per cent. annually on the reproduction cost of their physical assets alone. I believe this would be true of our railroads taken as a whole. Or we can say that the total par value of the stocks and bonds of all our railroads does not equal the cost to reproduce their physical assets. It is not unlikely that this statement will be received, even in certain quarters in the United States, with doubt and perhaps derision. But I venture to believe that some of our public service commissions—those competent, fair, and courageous, who might have laughed at this statement a few years ago—would, as the result of their experiences, now lend it their support.

In our gas and electric rate-fixing cases—in the first instance generally tried before the State Public Service Commissions—we are called upon to meet commission and court decisions which are far from being consistent. In general, the service rate of charge must be one which allows of a "fair return" (whatever that may mean) upon the value (whatever that may mean) of the property "usefully employed." Perhaps the one element, which is included in all decisions, is the appraised value of the plant. Some courts have defined this as the cost to reproduce new, less "depreciation." This is the dictum the public service corporations are most generally called upon to face.

Many questions are here introduced as to what constitutes the reproduction cost. Shall the unit prices be those quoted at the time of making the appraisal? As this might work for or against the corporation under fire, it is sometimes suggested that the average prices for the last five or more years should be used. Here there is a fine field for argument, and especially on the part of the experts, lawyers, and others opposed to the public service corporations. A prolific source of debate is the question of pavements over mains. If the mains were laid before the pavements, should the company claim the cost of pavement as adding to the cost to reproduce new? If the company were selling its property, whether the pavements were laid before or after the pipes, the price would be enhanced by reason of the mains being under pavement.

Some commissions and courts include the value for sale of the property as a whole as an element for consideration. Others, like the California Commission, exclude this element from consideration in a rate-fixing case. As a general rule, the companies must be prepared to meet any and every contention which has received any measure of approval at the hands of any commission or court, no matter how inconsistent these several contentions may be when introduced in the same case. The company may have to face a selection of all the elements least favourable to its case, irrespective of consistency. The opinion of the Massachusetts Commission in the Attleboro case, recently decided and previously referred to, is notable for its inconsistencies.

In the making of an appraisal, there are other items to be considered which are prolific sources of disagreement, either as to their admission or as to their measure—such as preliminary expenses, interest and taxes during construction, omissions and contingencies, engineering organization during construction, insurance, compensation of general contractor (including his expenses), "going value," &c. Fortunately there is a fairer disposition now in evidence as to the admission of these "overhead charges," though there is still ample room for improvement in the interest of justice to the investor. The Public Service Commission of the Second District of New York has done more than its share in developing sane and fair methods in these and other connections. The Wisconsin Commission also has shown a disposition to be fair and independent in its statements of principles, though it has not always been keen to be guided by the principles so enunciated.

It is not my present purpose to discuss at length these and other items which we have to consider in our rate-fixing cases. I may say, however, that these items, of which depreciation is one of the most important, if not the most important all things considered, are to-day questions of vital importance to many of our Public Service Companies. I have referred to these matters in the effort to disclose the atmosphere in which we have to fight for justice.

The subject of "depreciation," as connected with the making of appraisals for rate-fixing cases, has been greatly complicated by being involved with the estimates made to cover each year's share of the cost of final renewal or replacement of plant—this to be included as one of the year's items of cost of operation. The estimate is made, and the annual debit to loss and gain and credit to a reserve account are made, solely for the purpose of spreading more evenly over the years of the plant's service the cost of that portion of maintenance which is not covered by current expenditures for repairs and minor renewals. This estimate of final renewals is supposed to include the elements of physical decay, obsolescence, and inadequacy.

Unfortunately, as I think, we have not infrequently included in this estimate some reserve for extraordinary hazards outside of final renewals. This introduces an unnecessary complication, particularly when it is claimed that the plant has depreciated to an amount represented by the balance to the credit of this depreciation reserve. By segre-

gating the charge for final renewals from contingencies and hazards, we would be in a position to support more effectively our three claims—namely, the inclusion of an annual cost charge to cover final renewals; the inclusion of a reasonable charge for the creation of a limited reserve for contingencies and hazards; and the exclusion of a depreciation deduction from our plant appraisals in rate-fixing cases.

We will assume that the estimate of the annual cost of final renewals of the several parts of the plant is made on the basis of a compound interest sinking-fund. The total amount required each year to be charged to loss and gain and credited to reserve will be made up of the several amounts required to replace the several parts of plant at the end of the several expectations-of-life which we, in our wisdom or unwisdom, assign to each part of the plant. These parts will be grouped together according to the assigned expectation-of-life. The amount annually required for each group will be the sum which, accumulating at compound interest for the years assigned, will equal the cost of the plant—or the cost less such an amount as we believe we can recover in disposing of displaced parts of the plant.

It is thus seen that the total amount credited to reserve each year is the sum of the amounts required for the several sinking funds; the number of such sinking funds being the number of different lengths of life we have assigned to the several parts of the plant. This bringing together of the amounts required by these several sinking funds is convenient in our accounting; but it has led to further complication by bringing into the problem the so-called "average life" of the plant. The use of this term is constantly creating the impression that the plant lives to the term set by the average life and then has to be renewed as a whole. Nothing could be farther from the truth.

To show that in a sinking-fund scheme there is no length of time which is mathematically the average-life, it can be pointed out that this term will vary in length with the rate of interest by which the fund compounds. For instance, I have before me a very simple expectation-of-life table in which there are assumed only five groups of parts of plant as follows: Group "A," 10 years, $25,000; Group "B," 15 years, $50,000; Group "C," 25 years, $100,000; Group "D," 35 years, $150,000; and Group "E," 50 years, $175,000; total, $500,000. The true average-life formed by dividing in each case the cost by the expectation-of-life, is 28·378 years; whereas the so-called "average-life" for a 2 per cent. sinking fund would be 28·2 years; for a 4 per cent. sinking fund, 27·73 years; and for a 6 per cent. sinking fund, 27·05 years.

To emphasize the point that this average-life should not be allowed to misguide us, and further that the sinking fund is in fact a collection of sinking funds, it may well be noted that in the life-table above given the several groups of plant will be renewed within the fifty years which completes the cycle, as follows: Group "A," 5 times; Group "B," 3 1-3 times; Group "C," 2 times; Group "D," 1 3-7 times; and Group "E," 1 time. Here it can be seen that while the term average-life may be convenient for use by those who understand the subject, it may readily lead into error those who have that little learning which is so dangerous.

This brings me to three points which must be kept constantly in mind in connection with the study of the problems in depreciation.

1.—The depreciation reserve, or, more correctly, reserve for final renewals, is set up for the purpose of spreading the cost of final renewals of parts of plant as uniformly as possible over the periods during which the several parts are expected to render effective service; thus obviating unnecessary fluctuations in cost of operating, and so making it more practicable to keep the rates of dividend as uniform as possible.

2.—The amount to be so charged annually to loss and gain, and credited to reserve, is based on an estimate or assumption of the effective life of each part of the plant, considering the elements of physical decay, obsolescence, and inadequacy. There is here the opportunity for the exercise of the highest judgment recognizing the difference between hypothesis and theory and keeping in mind all the limitations of practice. To cover the element of obsolescence, we must know the present state of the art and prophesy as to the future. As to inadequacy, we must estimate as to the future increases in demand for service. As to physical decay, we are limited as to the future by the character of the management, over which we may have no control. Necessarily, then, this estimate is subject to correction. It must be based upon certain assumptions; and these assumptions as to design, construction, operation, and accounting, must control so long as the estimate goes uncorrected. This should mean that the estimate must be constantly open to correction as additional general or specific experience is gained. It should also follow that no tables of averages are applicable to any specific case.

3.—The loss will not have to be met until the replacement actually is made. It is an accruing liability against an obligation not yet due. Hence, if we take out the year's share of the accruing liability, as the payment is not yet due, the fund should receive the benefit of interest accumulations until the time for payment arrives. So far as the plant's capacity for rendering efficient service to the buyer of service is concerned, it by no means follows that the plant has depreciated to the extent of the balance to the credit of the reserve, and that this amount, or any amount, should be deducted from the appraised cost to reproduce the plant new. On the contrary, the fact that such a renewal reserve is being maintained is the strongest argument that all that is possible is being done to provide against impairment of investment and impairment of service efficiency.

The liability to renew or replace the plant rests upon the proprietors; and here is the best indication that this liability is recognized and provided for.

Let us now consider a case of appraisal of plant for rate-fixing. We will assume that the plant is being maintained in efficient condition through repairs and minor renewals paid for from current income; that final renewals are being made as required and the cost debited to the final renewal reserve; and that we are debiting each year to loss and gain and crediting to final renewal reserve the amount indicated by the estimate based upon the expectation-of-life of the several groups of plant. Of course, it is to be understood that where reserve is credited on account of liability for future renewals, when those renewals are made, the expenditures therefor should be charged against reserve and not against the year's operating expense. I may emphasize this point because some have been misled by thinking that we purpose to build up the reserve indefinitely.

Now let us further assume that the appraisal of plant for rate-fixing is in continuous operation, and that depreciation is to be deducted as indicated by our table of expectations—of life for the several parts of plant, and as advocated, unfortunately, by some commissions and courts, and not always opposed by those responsible for the protection of investments. The result would be the eventual elimination of all the investment in plant. For as each life group of plant reached the age at which the tables declared it was to be renewed or replaced, the deduction for "accrued depreciation" would equal the original cost. So as each group of parts of plant came to the time for renewal or replacement, that portion of the investment would be deducted from the plant appraisal, and there would be no provision for re-establishing the assets, because expenditures for repairs, renewals, or replacement cannot, as a general proposition, be capitalized.

I say here "as a general proposition." I leave the way open for exceptional cases, such as the rapid and abnormal obsolescence experienced in the development of the electric lighting and electric railway industries. Here the allowed rates of charge for service were not sufficient to pay a "fair return" on the investment and maintain the integrity of the investment. To require the proprietors to meet the total renewal charge in such a case as this would only spell confiscation.

Now let us consider specifically certain questions which are raised in our rate-fixing cases, and which trouble even some of the lawyers and experts engaged to appear for the companies.

Question No. 1: If you are not willing to deduct for "depreciation" in your appraisals of plant, why do you claim the right to include an item for "depreciation" in the cost of gas? Answer: The income from the operation of the property should first pay all items of operating cost, including administrative charges, taxes, and the maintenance

of the integrity of original and supplementary investment. The cost of the final renewals or replacements of plant, as well as the repairs and minor renewals currently made, must, then, be paid for from income. This means that the cost of final renewals—or what is usually called estimated, accrued, or theoretical depreciation—is an item to be included first or last in the cost of gas.

As the cost of final renewals does not generally fall evenly on the succeeding years, we may estimate the cost thereof and divide it evenly over the years involved. Unless this is done, the cost for the year or years under examination may be below the average, by reason of the non-inclusion of the year's proportion of cost of final renewals and replacements. Or it might happen, if there had been expenditures for final renewals or replacements far above the average, that the cost of gas might be unduly high. In either case, the rate of charge would be based upon an incorrect statement of average cost. This serves to explain why some companies are now properly including in their statements of cost an item to cover the cost of final renewals, although they did not include such an item befcre the days of rate regulation. The mere fact that the effort is made to spread this item of cost over the years involved is no argument one way or the other for a deduction for depreciation in the case of a plant which is being properly maintained and is rendering efficient service. This is a legitimate item of cost; and the item being acknowledged as a charge against income, the liability rests against the proprietors whether or not a reserve is established to meet this liability.

This point is well made in a brief on this subject submitted by Charles F. Mathewson, of the New York Bar, in the case of *King's County Lighting Company v. The Public Service Commission for the First District of New York*. Mr. Mathewson was the trial lawyer for the Company in the celebrated New York Consolidated Gas Company case. The brief now quoted from considers this question chiefly from the legal standpoint. It is the best paper on this subject I have ever read; and I believe it is the most logical that ever has been written. Mr. Mathewson says:

> The proposition [to deduct "accrued depreciation" in valuing plants in rate-making] is so absurd on its face that it hardly needs discussion to show its fallacy. Why, aside from the question of "confiscation," should consumers, for exactly the same service, equally efficiently rendered, expect to pay less in the sixth year than in the first year, merely because some items of plant will (viewed at the sixth year) require replacement at a date in the future then nearer than such date was at the beginning of operation? As well might it be claimed, to repeat a homely illustration, that a farmer should regulate the price of the eggs which he sells, by the age of the hen which lays them—reducing the price of the product as the hen gets on in years. The reason he does not is that the service efficiency and operating value of the hen, as evidenced by the quality of the eggs which she lays, are not impaired by the fact that her life is advancing. That advancement may concern the farmer and possibly concerns the hen; but it in no manner affects the value of the eggs to the consumer, or justifies him in demanding them at a lower price than he paid at an earlier period of her life. The consumer of the eggs must expect to pay a sufficient price to afford a return to the farmer on his total investment in the hen during her life, *plus* enough more to enable the farmer on her death to replace her and thus keep his investment unimpaired. A farmer could hardly be expected to invest in hens for the purpose of supplying the public with eggs, if for a portion of their life he was to receive a return on only a third or a half of his investment; and any such rule would simply compel the public to go without eggs until the regulating power (if such there were) saw fit to revise its reasoning. There is absolutely no difference in the economic principles applicable to the operation of a gas plant and the operation of a hennery, so far as concerns right to return on capital; and what is absurd in one case is equally absurd in the other. The fact that the rate of return in the one case is subject to reasonable regulation, and not in the other case, has no bearing on the main proposition.

This question can be further answered by the statement that if the final renewals were so evenly distributed over the years as to make a practically uniform annual charge, there would be no occasion for a renewal reserve, and there would be no occasion for raising this question. For instance, suppose we bring into the shop for testing and repairing such a number of consumers' meters that the whole number in service is completely overhauled in sequence every five years. Each meter is examined, cleaned, parts repaired or renewed as found necessary, or condemned and replaced by a new meter. The cost of all this work, including the new meters to replace those condemned, is charged each year into the cost of distribution, and so into loss and gain.

Here there would be no need for any additional item to be included in operating cost to cover final renewals of this portion of the plant. The cost of maintenance and final renewals would thus be more accurately distributed over the years than by means of any estimate based upon expectation of-life. Furthermore, the plant would so be maintained to the highest possible degree of service efficiency. Certain experts of repute have, unfortunately, taken the position with regard to plant so maintained by approximately uniform renewals that depreciation should be deducted from the appraised cost to reproduce new.

As further examples we may consider the ties of a railroad or the poles of a telegraph company. The assumption has been made that these would have a ten-year life, and that one-tenth of the total number would be replaced each year. Then it has been assumed that the average *age* of these ties or poles will be five years, and so there is a 50 per cent. depreciation which, in a rate-fixing case, must be deducted from the cost to reproduce the plant new. As a question of averages, the statement may be correct. As a basis for deducting 50 per cent. from the investment in this portion of the plant, it is without the slightest warrant in equity or common sense. This procedure deprives the investor of a return upon one-half of his investment in this portion of the plant, and so works confiscation. And this though the utmost that can be done is being done to maintain the service efficiency of the plant! And the service efficiency is the only feature in this connection in which the buyer of service has any just claim for consideration. A certain anthority has recently stated that a railroad soon after being put into operation will suffer depreciation of 15 per cent., and thereafter it can be maintained at 85 per cent. of its original cost by adequate current expenditure for maintenance.

In each of these cases, if there is of necessity a deduction to be made from the original cost to cover "depreciation," a deduction which cannot be avoided by entirely adequate expenditures for replacements, then an amount equal to the deduction for depreciation should be added to the appraisal as one of the necessary items of cost, on the same basis as interest during construction and the many other items other than material and labour as already mentioned. Certainly there is no reason, under these circumstances, including the maintenance of service efficiency, why the investor should submit to any such wholesale confiscation or to any confiscation, however small.

The whole question of depreciation may be cared for by the approximately uniform annual expenditures for final renewals. This condition is not infrequently to be found in the case of properties which are scattered over a number of locations, or have been built at different times widely apart. We have such cases in the United States, and I have no doubt there are many in Great Britain.

Question No. 2: "Having established a sinking fund to cover accruing and accrued depreciation (final renewals), why, in a rate-making case, should you not deduct correspondingly from the reproduction cost (new) of the plant?" Answer: Practically this is question No. 1 turned around; but it approaches the difficulty from another point of view. It has already been shown that the final renewal sinking fund is established to spread more uniformly over the life of the plant the cost of final renewals of the several parts of the plant. The establishing of the fund indicates a definite purpose to maintain the plant from income, and hence shows that there is no occasion to depreciate the investment in plant. This fund, whether invested in securities or additions to plant, claims its own earnings or interest accumulations to complete the amount required for renewals. Hence its earnings are appropriated in advance as a charge against income, and the fund cannot be taken as an offset to depreciation. If depreciation were deducted, the earnings from this portion of the investment indicated by the depreciation deduction would be eliminated, and so the investment to that extent would be confiscated.

Question No. 3: "If plant extensions have been made from the accumulations in the final renewal sinking fund, why should these additions to plant be included in the inventory of plant to be appraised for a rate-making case, and why should these extensions not be treated as duplications of capital investment?" Answer: This is a special case under question No. 2. When the depreciation sinking fund is drawn upon to pay for extensions or betterments, the amount is loaned from the credit balance of depreciation reserve, which balance is the accumulation remaining after the payments for the final renewals which have been made against the reserve. Here it is to be remembered that this reserve is being added to annually by the charges to operating cost and interest on accumulation, and is being reduced

from time to time as the parts of plant included in the expectation-of-life table come to be renewed or replaced.

Then all parts of plant which appear in the inventory or appraisal as having been paid for from the depreciation reserve fall in one of two classes: (1) Parts which have been installed as renewals or replacements, and are, therefore, in place of parts represented in the original investment, and hence to be included in the inventory as such. (2) Parts of plant which have been installed as extensions or betterments, and which have been paid for by money borrowed from the depreciation reserve. These parts should, therefore, be included in the inventory and appraisal because they are not a duplication of investment, but represent additional investment.

As has been shown, the balance to depreciation reserve should be credited each year with interest at the rate agreed upon. The money so borrowed has to be returned when required for final renewals, and must be repaid from capital. In the meantime, the Company has been able to defer the day for permanent financing. These extensions can be considered as capital investments; the amounts borrowed from depreciation reserve, with interest thereon, standing as a liability against the proprietors. In this connection, the point may again be made that, whether there is a depreciation reserve or not, the liability for renewals rests against the proprietors.

As to whether or not there shall be a depreciation reserve, concerns the proprietors, and in no way concerns the public or the consumers. In any case, the cost of final renewals must be paid from income; and it can work no hardship to divide this cost as uniformly as possible over the years of service. This could be done by estimating the cost per 1000 cubic feet without necessarily making any journal entries. The journal entries, and all that follows, are simply steps in accounting which make for greater accuracy and permit at any time the regulating authority to check-up the methods pursued. If the plant is not so maintained as to give efficient service, either by failure to make repairs and minor renewals from current income, or later to make final renewals, the liability rests upon the proprietors, and can be enforced by the regulating authority.

If the deductions were made from the appraisal of plant to cover neglected repairs or renewals, and then the deficiencies, under the orders of the commission, were made good, the investment would remain impaired, and so there would be confiscation. If the price were fixed on the basis of this valuation, so reduced by depreciation deduction, then the price so reduced would not be sufficient to give a fair return upon the entire necessary investment. If extensions to plant were made after this reduction in price, the price then could not afford a fair return upon this undepreciated additional investment. The final outcome would be, if this confiscatory procedure were continued, that the plants so affected would not be extended, and the public to be served would suffer. If it is claimed that the rate of charge would be increased to meet this restoration of the plant, the answer is that it is much easier to reduce than to increase a price, and especially so as to the service rendered by a public service corporation.

As a certain member of one of our most influential commissions said recently in this connection: "We are representatives of the People." It might be suggested that, as our public service corporations are largely owned by the small investors, either directly or through banking agencies, the commissions, if they are to protect all the People, should be encouraged to act impartially between the sellers and the buyers of service.

Our confidence as to the future is increased by the knowledge that some of our commissioners are strong enough and fair enough to take this position; and the number is increasing. One notable case can be referred to, of a man who went into office avowedly opposed to public service corporations, believing them to be what the interested politicians accused them of being, but at the end of his five years of very active service, publicly declared that he had found greater fairness, candour, and honesty with the corporations' representatives than with the representatives of the People.

Question No. 4: "In the making of plant appraisals for any purpose, should present actual depreciation be measured by reference to tables of expectation-of-life prepared for estimating accruing liability for final renewals, together with the ascertained present age of the plant?" Answer: If what I have so far said is conceded, it follows that the accrued liability referred to cannot be ascertained by reference to tables of averages computed from a study of plants dissimilar in many ways. Such an estimate of accrued liability, to support any claim to accuracy, must be based upon a careful and competent study, preferably extended through years, of the plant under examination.

If, then, we wish to know the condition of plant at any time, why refer to such tables? Why not examine the plant itself, having in mind its condition as to physical decay, obsolescence, and inadequacy? Certainly if we desired to learn the cost of an elaborate structure we would not consult the preliminary estimates of the architects, when we could have access to the treasurer's final and complete records.

Were it not for the fact that many prominent engineers are following the practice of using so-called standard tables in estimating present depreciation, deducting in proportion to the age of the plant, I should not think it necessary to treat this question seriously. This method, reduced to its simplest terms, is something as follows: A plant is assumed to have an average life of fifty years. The average age is found or assumed to be twenty-five years. Result, depreciation 50 per cent., investment impaired 50 per cent.

Perhaps it is unnecessary to say that the men who err most radically in this direction are book-men, who have had little or no practice to balance their faulty or incomplete theories. In the United States, the professors of economics and statisticians are much in evidence at present; and many of these men are striking examples of the "blind leading the blind." The recklessness of statement indulged in by some of these men, depending as they do upon the reading of books, often each other's books, is simply appalling. It is still more appalling when we reflect that not a few of these men are teaching their destructive doctrines to the young men attending prominent colleges and universities.

To determine the amount of actual depreciation of a plant presents many difficulties, and calls for superior capacity founded upon scientific attainments and broad and exact experience. This determination may be required in connection with a change in ownership, that it may be known what expenditure, in addition to the purchase price, is required to bring the plant up to the required productive capacity and efficiency. Or, it may be required to check the accuracy of estimates on the cost of maintenance, including final renewals. Or, it may be required by a public service commission to test the justice of a complaint as to faulty service. In any case, the facts are to be learned by expert examination of the plant itself, having in mind physical decay, obsolescence, and inadequacy. If life-tables are employed, they should be used with the utmost caution, and then only as a most general guide, and never by those who have not had adequate experience as constructors and operators. Perhaps the greatest danger in these tables is that they encourage those who are incompetent to think they are competent.

Question No. 5 (a question recently asked): Assume, a plant that cost $100,000; average life, 40 years. At the end of the first year's operation there has been charged to loss and gain $2500 (100,000 ÷ 40) as the year's proportion of depreciation, and a satisfactory dividend has been earned and paid to the shareholders. Then, as the shareholders have received a satisfactory return on their $100,000 invested. and have also had returned to them $2500 of their principal, what right have they to demand a return next year on more than $97,500?

Like many of the questions asked by the cross-examiner, this question, either through design or failure to understand the principles involved, is based upon faulty premises, and involves an unwarranted assumption. If the average life were forty years, $2500 should not be charged to loss and gain to cover the year's depreciation; but there should be charged such a yearly payment only as through the operation of a sinking fund would be required to redeem the $100,000 at the end of forty years—and this for the purpose of renewing or replacing the plant. The end sought is so to maintain the plant as to maintain the integrity of the investment. The maintenance of the plant includes repairs, minor renewals, and final renewals. In this particular case, the amount so required for a 4 per cent. sinking fund would only be $1050.

Whether $2500 or $1050 has been charged to loss and gain against income, this is not a return of part of the investment, because, when correctly estimated and computed, it is part of the cost of maintenance, and hence a charge

against cost, quite as much so as repairs and minor renewals. [I apologize for repeating such a self-evident proposition, but it seems to be necessary.] Again, if the amount charged is $1050, as it should be, this amount, and the succeeding payments, must be invested in one way or another so that the earnings or interest on the annual payments may also be added to the fund to produce the required $100,000. When we bear in mind that for a forty-year amortization at 4 per cent. the forty annual payments only aggregate ($1{\cdot}05 \times 40 =$) $42 per $100, and the interest accumulations have to produce the required remaining $58, perhaps we can better appreciate that the annual renewal reserve payments cannot work as earners of dividends for the stockholders. But they have their separate work to do for the stockholders in earning interest to be applied to the protection of the investment.

It is to be remembered by those who are puzzled by question No. 5 that the $100,000 plant must continue to be a $100,000 producer of service year by year. If depreciated to $90,000 at the end of the fourth year, only a $90,000 service should be expected then from its operation; at the end of the thirty-ninth year, only a $2500 service should be required from its operation.

Over and over again the question is raised in one form or another: If the consumer has been charged for depreciation in the rates, why should he be charged again through failure to deduct for depreciation? The depreciation, or cost of final renewals, is part of the operating cost; and there would be just as much reason for reducing the investment because certain amounts have been charged into operating cost for coal, wages, salaries, &c., as there would be for reducing the investment in plant because the cost of maintenance has been included as part of that cost.

Finally, nothing that I have said as to the determination of actual "depreciation" is to be taken as an admission that in a rate-fixing case any deduction should be made from the appraised cost to reproduce plant new to cover so-called accrued depreciation, or, more correctly speaking, the accrued liability against the stockholders for final renewals or replacements. This is a liability resting against the proprietors; and they must be given the normal opportunities to meet this liability without in the meantime suffering confiscation of investment by anticipation of the dates when the several payments to meet this liability may fall due. It is the part of wisdom for the owners of properties to reserve from income all that may be required to preserve intact their property investments; but this establishes no reason for deductions for depreciation in connection with rate-fixing.

THE BENEVOLENT FUND.

MEETING OF DONORS AND SUBSCRIBERS.

On Wednesday morning, the Annual Meeting of the Donors and Subscribers to this fund was held—the President in the chair.

The Hon. Secretary (Mr. Walter T. Dunn) read the minutes of the last annual general meeting, which, by the consent of the members, the President signed as correct.

The President: Gentlemen, I beg to move that the report and accounts of the Benevolent Fund [*ante*, p. 654] be received and adopted. In doing so, I will only occupy a few moments in commending them to you. They show that we have spent lately some £20 more than has been received; and I take this as the text for an urgent invitation to all members of the Institution to become contributors. We do not ask for large contributions; it would not be necessary, if all did their share. But I do think, knowing as we do what happens in the course of many professional men's lives, that it is a duty incumbent on us to see that this fund is kept in a satisfactory condition. The action of our old friend Mr. Newbigging yesterday has helped the fund; and while we accept it with much gratitude to him, it is not that kind of contribution which we want. We want small contributions from all our members. It has been my duty to bring one or two cases before the Committee; and I am grateful to say that they have always been met and dealt with generously. But I am quite sure there are many other cases where relief would be very welcome and useful, but which are not brought forward, because there is an impression that our fund is a little one and cannot stand it. I beg to move the adoption of the report and accounts.

Mr. J. Ferguson Bell (Derby): Mr. President and gentlemen, it affords me great pleasure to second the formal adoption of the Benevolent Fund accounts. I can echo what you, Sir, have so well expressed—namely, the desirability of all the members of the Institution subscribing to this fund. It has been my lot to bring before the Committee certain cases; and I can say that the Committee have acted most generously towards these cases, and that the help that has been given has brought some little comfort to those who are unable to provide for themselves. I would very cordially ask all the members of the Institution to subscribe. As you have said, Sir, it is not large subscriptions that we want; but we want every member of the Institution to believe that it is part of his fund, and to become a subscriber. The fact that we are nearly £20 behind this last year shows that we want additional subscriptions. The appeals made for funds from year to year have had a good effect. The amount received has been increasing; but the sum required seems to increase to a greater degree than the amount of subscriptions. I would therefore ask every member to subscribe.

The resolution was then put and carried unanimously.

The President announced that Mr. W. Doig Gibb and Mr. Charles Meiklejohn had been elected to take the place of the retiring members of the Committee—Mr. Thomas Berridge and Mr. Henry Woodall.

Masonic—Evening Star Lodge, No. 1719.

In accordance with custom of many years' standing, the W.M. (W.Bro. William Edgar), wardens, and brethren of the Evening Star Lodge held an "Emergency Meeting" at the Freemasons' Hall on Monday of last week, to welcome the members of the Institution of Gas Engineers and other visiting brethren to London in connection with the Jubilee Meeting. The proceedings took place in the Grand Lodge Temple, Great Queen Street; the business consisting of the initiation of Mr. Edwin Hazzard Harman, of the Gaslight and Coke Company, Beckton. Among the officers who took part in the ceremonial were: W.Bro. Cyril G. Davis, P.M., Director of Ceremonies; W.Bro. Jacques Abady, P.M., Assistant Director of Ceremonies; W.Bro. C. W. Offord, I.P.M.; W.Bro. E. G. Smithard, S.W.; W.Bro. A. E. Croager, J.W.; Bro. J. F. Wicks, S.D.; Bro. A. P. Main, J.D.; W.Bro. Fred J. West, I.G.; Bro. J. F. Simmance, Organist; Bro. Henry Kearns, Steward. Afterwards, in a graceful speech, the W.M. expressed the pleasure that he and all the members of the Lodge felt at having the privilege of entertaining Masonic brethren from the Provinces, as also some few from abroad. Subsequently, a banquet was held in the Connaught Rooms; and this was followed by a Smoking Concert, interspersed with a few toasts. After the "Initiate" had been given, the "Visiting Brethren" were toasted; and in response, the following distinguished guests were called upon: W.Bro. S. Meunier, the W.M. of the Northern Star Lodge; W.Bro. Vincent Hughes, W.M. of the Murdoch Lodge; Dr. Arthur H. Elliott, of New York; Bro. A. W. Edwards, of Copenhagen; Bro. Frederich Lux, of Ludwigshafen; and Bro. Sir W. Ryland D. Adkins, M.P. The proceedings, in which some 250 brethren took part, were thoroughly enjoyed.

OBITUARY.

The death occurred suddenly, on Monday last week, of Mr. HARRY HOWELL, who had for seven years been associated with Messrs. W. C. Holmes and Co., Limited, of Huddersfield. Before entering their service, he was for seventeen years with Messrs. C. & W. Walker, in the capacity of Assistant-Manager. His death will be much regretted by a large circle of friends; and great sympathy will be felt for the bereaved widow and family.

PERSONAL.

In connection with the Roads Congress that is being held this week, Mr. C. CARPENTER, D.Sc., and Mr. S. Y. SHOUBRIDGE, are the representatives of the Institution of Gas Engineers on the Organizing Committee.

Mr. JAMES BLACK, who has been Gas Manager at North Berwick for a considerable number of years, has recently retired; and the Town Council have appointed Mr. R. B. Chalmers, who is at present Gas Manager at Alva, to succeed him.

Last Saturday, Mr. and Mrs. CLAYTON celebrated their Golden Wedding at Oak Hill, Shadwell; and in connection with the event a full programme of sports and festivities was gone through. Mr. Clayton is the Managing-Director of Messrs. Clayton, Son, and Co., Limited, of Hunslet, Leeds; and presentations of pieces of plate, two fine bronzes, and his portrait in oils, painted by Mr. E. Crowther (one of the workmen), were made on behalf of the officials and workpeople. Next year will be the jubilee of the foundation of the business.

We heartily congratulate Mr. W. E. PRICE, of Hampton Wick, upon his election to the Honorary Secretaryship of the Institution of Gas Engineers, in succession to Mr. S. Y. Shoubridge, who has resigned the office on account of the increasing duties devolving upon him through the large amalgamation in which his Company have been concerned preventing him giving such time and attention to the duties of the Honorary Secretary as is desirable. The new Honorary Secretary is as well known to the members of the gas profession in London and the southern counties as any man, but it is just possible that he may not be known to all members of the Institution farther afield. Therefore we reproduce a photograph of Mr. Price which will enable all the members to recognize their new Honorary Secretary.

Photo. by W. Haine, Teddington.

MR. W. E. PRICE, of Hampton Wick.
The New Honorary Secretary of the Institution of Gas Engineers.

MESSAGES OF CONGRATULATION ON THE INSTITUTION JUBILEE.

DURING the meeting last week of the Institution of Gas Engineers the following messages from abroad were received and read; and each one evoked expressions of the heartiest appreciation.

Letter from the GERMAN ASSOCIATION OF GAS AND WATER ENGINEERS.

The Council of the Deutscher Verein von Gas-und Wasserfachmannern is greatly obliged for the kind invitation to attend the Jubilee Meeting of the Institution of Gas Engineers, and has instructed the following gentlemen, Geheimer Rat, Professor Dr. Hans Bunte, Karlsruhe, Honorary Member of the Council, Director William W. Drory, Frankfurt a/M., General Director E. Körting, Berlin, and Director H. Prenger, Cologne, to represent the Society at the Jubilee Meeting in London, and has asked them to convey to the English mother Society the most heartfelt congratulations, and to express the great and friendly admiration of the achievements of the English gas industry under the guidance of the Institution, and to convey our best wishes for a continuance of this development, and to convey from all the colleagues the hearty greetings to the several members, a large number of whom are known to our members. Wishing you a successful celebration.

Telegram from the GERMAN GAS JOURNAL.

Takes a very hearty interest in the Jubilee of the Institution of Gas Engineers and sends the heartiest good wishes for the continuance of the prosperity of the Institute.

Dr. KARL BUNTE, Karlsruhe.

Telegram from M. DE BROUWER, *Bruges*.

Please accept all my excuses and present them to Sir Corbet Woodall and colleagues. Am detained in Belgium by unforeseen circumstances.

Telegram from M. A. WEISS, *Zurich*.

Regret very much that at the last moment I have been prevented from coming to London. If possible will send someone in my place. Letter follows. Greeting.

Telegram from Herr W. VON OECHELHAEUSER.

With my heartiest congratulations to the great success of fifty years' work, please accept my most sincere wishes for a splendid future of the Institution in good English-German fellowship.

Telegram from the GERMAN CONTINENTAL GAS COMPANY.

Our hearty congratulations for the fifty years jubilee, coupled with the hope that a glorious past and a successful one for the gas industry of the whole world may for the British Institution be followed by a prosperous and splendid future.

Cable from MR. W. R. ADDICKS, President of the AMERICAN GAS INSTITUTE.

Congratulations fifty useful years. Best wishes.

Telegram from the SWISS ASSOCIATION OF GAS AND WATER ENGINEERS.

The Swiss Association of Gas Engineers send hearty congratulations, and wish full success to the future work of their British colleagues.

A. WEISS, *Zurich*.

Telegram from LA SOCIÉTÉ TECHNIQUE DE L'INDUSTRIE DU GAZ EN FRANCE.

La Société Technique de l'Industrie du Gaz en France, meeting at Toulouse, sends to Sir Corbet Woodall, President of the Institution of Gas Engineers, the expression of its most cordial wishes on the occasion of the Jubilee of the Institution. M. Robert Ellissen, delegate of the Société, is specially charged to assure our English colleagues of our sincere regard.

BOUTAN, President.

Reply to the FRENCH SOCIETY.

President, La Société Technique de l'Industrie du Gaz en France, Toulouse.

The President, Council, and Members of the Institution of Gas Engineers return thanks for the kindly message of congratulation sent them by your Société, on the occasion of the Institution's Jubilee. They also gratefully acknowledge the courtesy of the Société in sending to London a representative so peculiarly acceptable as M. Ellissen. With fraternal greetings, Woodall.

SOCIÉTÉ TECHNIQUE DE L'INDUSTRIE DU GAZ EN FRANCE.

THE FORTIETH ANNUAL CONGRESS—Toulouse, June 17 to 19, 1913.

REVIEW OF THE PROCEEDINGS.

[FROM OUR OWN CORRESPONDENT.]

THE Fortieth Annual Congress of the Société Technique de l'Industrie du Gaz en France was held at Toulouse last week, in the old and magnificent Hôtel d'Assézat, erected in 1555 by Nicolas Bachelier, a native of the city, for a rich merchant. Never was an association of gas engineers and managers so sumptuously housed. M. AUGUSTE BOUTAN, the Managing-Director of the Lyons Gas Company, the President of the Society for 1912-14, occupied the chair; and the proceedings at the meetings were followed by a numerous attendance of members. Among those present were: Mr. Charles Carpenter, Mr. Evans, Mr. Duckham, M. Prisse, and M. Busine—the two latter being the Past-President and the Vice-President of the Belgian Gas Association.

General Meeting.

The first business was the presentation of the report of the last congress, held in Paris in June, 1912, as contained in the volume of "Transactions" published in October, and duly noticed in the "JOURNAL." It was unanimously adopted. Then came the election as honorary members of M. Blondel, the Chief Engineer of the Ponts et Chaussées, who is well known for his valuable works on photometry; Mr. Charles Carpenter, the Chairman of the South Metropolitan Gas Company; and the President for 1913-14 of the Institution of Gas Engineers (Mr. Edward Allen). There were also elected 45 new ordinary and associate members.

Medals and Awards to Employees.

The Prefect presented the Government medal to a number of employees who had completed thirty years' service in the same works.

Subsequently M. Koechlin submitted the report on the premiums and medals given by the Society to old servants in the gas industry. He explained the conditions under which will be awarded silver plated medals to employees, and silver and silver-plated medals to workmen. In addition there will be prizes of 300 frs. and 500 frs., offered by the companies with which the recipients are associated. As from the present year, these arrangements will apply both to workmen and to foremen. The number of candidates for these prizes increases year by year. This time there were 246 whose period of service ranged from forty-three down to twenty-seven years; and it was decided to award premiums to eighty of the oldest and most deserving among them. A goodly number were in attendance to receive from the President, amid the applause of the members, their well-merited reward for long years of labour.

Prizes for Papers.

Four of the papers read at last year's meeting were by members of the Committee, and consequently their authors were ineligible for prizes. They were the communications of M. Masse, on the supply of coal to gas-works, and the mechanical keeping of the accounts of a gas undertaking; of M. Laurain, on the estimation of naphthalene in gas, as carried out in the Paris Gas-Works; and of M. Guillet, on the contamination of gas in holders. M. Bertin's communication on heating by radiation, which was regarded by the Committee as one of the best papers submitted at the meeting, gained for the author a prize of 400 frs. M. Grebel, it may be remembered, submitted three communications, the most important of which was certainly that on "Comburimetry." The Committee have decided to retain this paper, as they regard it as a valuable one. The other contributions by M. Grebel dealt with an economizing reflector and a self-lighting tap. For the three papers he has been awarded 200 frs.

Report of the Treasurer.

M. Frière, the Treasurer, presented his report, which showed that the expenses of the Society last year were 98,348 frs. (£3934), and the receipts 94,913 frs. (£3796). The former included 13,423 frs. for premiums, 15,475 frs. for publications, and 2499 frs. for investigations, the library, &c. At the close of the year, the Society's capital amounted to 231,443 frs. (£9258), compared with 214,716 frs. (£8589) on Dec. 31, 1911; being an increase of 16,727 frs. But a sum of 12,510 frs. has to be deducted for amounts belonging to 1912 which have to be paid this year; so that the increase is really 4217 frs. (£169). This is due to the additional financial support generously accorded to the Society by different gas companies.

Report of the Committee.

M. Gaston Gautier, the Manager of the European Gas Company at Havre, the Secretary of the Committee, presented, in an interesting report, the account of the Society's work last year.

He began by paying a last tribute to the memory of those members who, in the course of the year, had been removed by death. Among these were to be found the names of M. Brandt, for many years Manager of the Saint-Josse Ten Node Gas-Works, before being put at the head of the Bucarest Gas and Electricity Company; M. Chossler, M. Covillon, and M. Durandy, all of whom held prominent positions in the gas industry. Losses by death or retirement, and the admission of new members, left the composition of the Société Technique as follows: Honorary members, 23, belonging mostly to the British industry; ordinary members, 683; associates, 152—total, 858. Contributions from gas companies to the funds totalled 33,510 frs. (£1340) against 31,760 frs. (£1270) for the previous year—proof enough of the professional solidarity of the companies, and an acknowledgment of the good work being done on their behalf by the Society.

The Committee had had to reply to the circular, dated Aug. 20, 1912, issued by the Minister of Commerce and Labour, dealing with the proposed modifications in the laws relating to weights and measures, and they had naturally been particularly interested in this opportunity of fixing legal standards of heat and light, and of assuring the official testing and stamping of meters. On the proposition of M. Vautier, the Society had passed a resolution: "That a unit of light (unit of luminous intensity) should be fixed by law, and defined as follows: The unit of any simple light is the quantity of light of the same kind given off in the normal direction by a square centimetre surface of molten platinum at the temperature of solidification. The practical unit, equal to one-twentieth of the unit thus defined, shall be called the 'international candle'—already adopted by the national laboratories and the gas and electrical industries of France, England, and the United States of America. The Society, in addition to having passed this resolution, had interested itself in the experiments made by the Central Laboratory of Electricity on the subject of the Violle unit. As to stamping of meters by the State, seeing that guarantees are offered by the municipal testing departments and company controls, and that the introduction of an official stamp could only create difficulties in case of the imperfect working of meters and would also incur useless additional expenses for the gas-works, the Committee had addressed an urgent plea to the Ministers in favour of the *statu quo*, which is satisfactory to all parties.

The Secretary then passed briefly in review the work of the different Commissions [noticed elsewhere].

The general report further stated that the Professional Syndicate of the Gas Industry, with M. Marquisan, its President, had expressed its views as entirely in accordance with those of the Committee on the important questions of meter-stamping and lighting units. The Syndicate had been particularly occupied with the question of the tax on light, and had issued a brochure of protest, intended to enlighten municipal and general councils on this dangerous scheme, the results of which would be as annoying for the consumer as for the gas people, and the application of which would be attended by the greatest difficulties. The Committee had been represented at the gas exhibitions organized respectively by the Dutch and Belgian Associations of Gas Engineers. The "Transactions" for 1912 had published some notes on the Amsterdam Exhibition, and the speech made by M. Masse, General Manager of the Société d'Eclairage, Chauffage, et Force Motrice, on behalf of the Société Technique. The next volume will contain an account of the visit of M. Laurain, Consulting Engineer of the Société du Gaz de Paris, to the Antwerp Exhibition. M. Boutan had, as usual, been elected an honorary member of the Institution of Gas Engineers, which was, on June 17, to celebrate the fiftieth anniversary of its foundation. The President of the Société Technique being, for obvious reasons, unable to attend the English meeting, the Society was to be represented there by M. Robert Ellissen, a member of the Committee, and a telegram was to be sent to the English Institution "bearing to our over-sea colleagues our heartiest wishes and congratulations on the occasion of this ceremony."

The question of the standardization of screw-threads had been broadened, and no longer referred merely to the connections on apparatus, but also to specialities for central heating, water, electricity, steam, &c. The Commission which had been entrusted with the consideration and arrangement of the many recommendations received had almost finished its arduous task. Its decisions had been adopted by a plenary assembly of French manufacturers, and it was probable that, after the meeting next October of the International Commission, an agreement would

be able to be established on a firm basis, to the advantage of all concerned. The best thanks of the Committee were expressed to M. Coze for presiding at the deliberations, and to M. Godinet for his important and valuable collaboration.

Some changes for the better had been introduced into the Society's system of prizes to workmen. Thanks to increased subscriptions on the part of some companies, the Society, while continuing the old awards, would be able to offer new and valuable ones to old servants of the industry. The Central Coke Committee of France, presided over by M. Rouland, had continued the prizes placed at the disposal of the Society for the best apparatus using coke or gas for domestic and industrial heating. To ensure the sale of the ever-increasing production of coke, the Central Coke Committee had organized the efforts of all the gas unions, and on their behalf, made agreements with foreign producers. The technical department, under M. Decluy, had succeeded in persuading a large number of industries to adopt coke for fuel after a fair trial.

After this exhaustive report of the work of the Société Technique during the past year, M. Gautier announced the large development which had taken place in the majority of gas undertakings. The competition of electricity is stimulating; light calls forth light; gas strives on, and often wins the victory. The field is a wide one, and the improvement of apparatus widens it almost daily. The application of gas to bakers' ovens is one of the happiest developments of recent times.

Opening of the Congress.

On Tuesday afternoon the Congress was formally opened by the Prefect of Haute-Garonne, who was supported in the chair by the Mayor of Toulouse and M. Boutan, the President of the Société Technique. Various prominent citizens of Toulouse were also present—notably M. Sabatier, associate member of the Academy of Science, M. Cartailhac, correspondent of the Institute, the President of the Chamber of Commerce, &c. The Committee was almost complete, and the general attendance excellent. A welcome innovation was the placing of an orchestra in an adjoining room, which rendered excellent selections during the intervals of the business of the session.

Presidential Address.

The President, M. Boutan, in a remarkable address, made a summary review of the state of present-day knowledge of the production and propagation of light. He recalled first the well-known facts of vibrations of the ether, which, according to their periodicity, spread their waves over areas of several kilometres for wireless telegraphy down to thousandth-parts of a millimetre for extreme ultra-violet rays. Then he mentioned the new theories, which the discovery of radio-activity has established on an almost certain basis, on the subject of the constitution of material molecules and the atoms of which they are composed, from which theories he deduced the manner in which calorific or electric vibrations are probably transmitted to the air by harmonic entrainment. Applying to the region of practice these considerations, M. Boutan pointed out the interest there would be in making further experiments to define the mean constants of the human eye, in order to establish a conventional basis of equivalence of luminous radiations of different wave-lengths. This equivalence should be based upon the useful effect produced on the eye by these various radiations. He then described a spectroscopic photometer, constructed by the Lyons Gas Company on his instructions, and based on the curve of mean sensibility of the human eye—the result of recent experience. This photometer, graduated once for all according to the international standard of light, would give independent measurements of the sensitiveness of the observer's eye.

The address, which was a very clear summary of the most recent chapters of the physics of light, of original ideas, and of new methods of spectro-photometry, was most enthusiastically received. It would have been difficult to approach these delicate questions with more simplicity and precision.

Reports of Commissions.

Professional Training.—The annual report of this Commission was read by M. Laurain. The most important question they had studied during the year was the formation of courses for various classes of men engaged in the gas industry, with a view to perfecting their professional capacity. Two solutions to the problem have been under consideration, and the main difficulty seems to be that interested parties are so scattered. For engineers, heads of offices, managers, &c., they plan a "quinzaine gazière" in Paris, which would bring them all together to receive general and constant instruction, including the study of fundamental questions; (2) general instruction on subjects varying from time to time, which would give to the meetings new interest. For certain sections of the profession, the Commission have under consideration the organization of travelling instruction, which would be given by a qualified person, who would visit works which applied to him. The Commission have examined the manuscript sent for the competition for manuals for the use of outside service men of medium works. The work submitted, although very interesting in certain chapters, can at present only be awarded an encouragement premium.

Manufacturing.—The report of this Commission was read by M. Guillet. This year they have been mainly occupied with the heating of furnaces by separate producers and a gas of constant quality which has been submitted, after cooling, to considerable purification. There are two installations of this kind at the Vienna municipal works, with Kerpely producers, improved by M. Marischka. The chief advantages claimed by the inventors are: The possibility of freeing the producer-gas from dust, and thus choosing a furnace system entailing a minimum cost for fuel; use of producers which clean automatically the fire-bars; simplicity of working, of installation, of fuel-handling, and production of a producer gas uniform in its composition.

The installation at Simmering, of a daily capacity of 150,000 cubic metres (5,295,000 cubic feet), consists in eight producers, working five at a time, each capable of dealing with twelve tons of coke per twenty-four hours; air is blown in at 200 m.m. pressure, and 0·4 kg. (0·88 lb.) of steam is used for each kilogramme of coke. The calorific power of the gas is 1250 calories.

The installation at Leopoldau was put up to produce 250,000 cubic metres of coal gas per day. It may be assumed that about twice this quantity of poor gas for heating the furnaces would have to be made; and, in reality, a second works would be necessary for its manufacture and purification. Consequently, expense would have to be incurred which seemed out of all proportion to the advantages cited above.

Applications.—In their report, the Commission said their work had been devoted to looking for appliances constituting marked progress; in other words, those which opened new outlets for the use of gas, or presented some advantage on the ground of price and convenience as compared with their predecessors. The Commission purpose putting themselves in communication annually with managers of works and makers of gas apparatus, with the view of obtaining from them information in regard to any new appliances, or improvement effected in those existing, of which they might have heard. They intend to take part in effecting progress in connection with gas appliances by themselves investigating those which appear to be of interest. This has been done, in regard to the heating of bakers' ovens by gas, by the Paris Gas Company, who defrayed the expenses attending the trial of several systems. The appliances presented for competition this year, though interesting from several points of view, did not show any special improvements, and consequently no awards were made in respect of any of them. The Committee make special reference to a bath shown by the John Company, which could be heated by a range of blue flames placed below it. The filling and emptying arrangements are simple, and the apparatus allows of a bath being obtained in the normal time at a very moderate cost.

Distribution.—This Commission issued a highly interesting report, having studied during the year the two prominent subjects of high-pressure distance distribution and high-pressure lighting. Thanks to documents obtained from the Société du Gaz de Lyon, they were able to give some definite information with regard to the limit of pressure to which gas can be submitted in relation to tightness of joints and illuminating power. The maximum pressure may be fixed at 6 ft. 6 in. of water. Although there are advantages in the use of long steel mains, yet their somewhat quick oxidation inclined the Commission to recommend cast-iron mains. Having had no time to verify other formulæ, the Commission recommend the Monnier-Pole formula for calculating the diameter of mains. Some numerical examples are given in illustration of this very clear review of high-pressure distribution, working with or without relay gasholders, and information is given on the financial side of the question.

High-power public lighting by high-pressure gas has been greatly developed in competition with electric lighting by flame arcs. Paris possesses at the present time more than 700 high-pressure lamps on the Colonia, Pharos, and Graetzin systems, representing more than 1,600,000 candles. To supply these lamps, 42 kilometres (25 miles) of special mains have been laid, and three pressure stations, with gas-engines for power, have been installed with a total capacity of 4200 cubic metres (148,000 cubic feet) per hour. The Paris Gas Company have erected a special laboratory for photometrically studying high-pressure gas.

Papers and Discussions.

The technical business opened with a paper by M. Jacquesson, in which he described a new design of fire-bars for use in gas-furnaces. Next came a paper by M. Marconnet giving particulars of a gas-producer of large capacity, which evoked some remarks from M. Pierson, who is an expert on this subject, and M. Rolland. This was followed by a discussion on the washing of clinker and the utilization of residuary combustibles. It afforded an opportunity to M. Versepuy, the Manager of the Toulouse Gas-Works, to give the members particulars of the hydraulic system of removing clinkers which they would witness in operation at the works. Furnaces worked with heavy tar oils were the subject of a communication by M. Stein. The author described two burners—one which allowed of the complete combustion of the oil, and the other by which the oil, instead of being gasified, is simply vaporized by a jet of compressed air; and he compared the cost of heating by oil, coke, and producer gas. A short paper describing an arrangement for cleaning ascension-pipes was submitted by M. Naudé. It has been adopted at the Chantilly Gas-Works; and the President thanked M. Naudé for having lightened one of the most laborious duties which gas workmen have to perform. M. Bachelay described a double-scoop retort-charging machine which is so simple in construction and so easy of manipulation that it can be employed anywhere. Moreover, it can be put up without the assistance of a specialist, and its cost is lower

than that of similar machines. It is in use at the Aubagne Gas-Works, where, according to a statement made by the Managing-Director (M. Bizalion), it is giving great satisfaction. M. Aublant brought under the notice of the members an appliance for lighting and extinguishing gas at a distance. M. Combes described a simple device, the invention of M. Grange, the foreman at the Toulon Gas-Works, by which charged mains can be tapped without fear of losing any gas. M. Bachelay, the Manager at Toulon, said he had used the appliance for twenty years for the repair of mains, and was perfectly satisfied with it. Without interrupting the flow of gas, it was possible to make an 8-inch connection on a 16-inch main.

An unusual and very interesting feature of the technical business of the meeting was the inclusion in the list of papers of one by an English gas engineer, and no less distinguished a member of the profession than Mr. Charles Carpenter, the Chairman of the South Metropolitan Gas Company. He dealt with the decomposition of the bisulphide of carbon in illuminating gas by means of hot purification. The subject of the composition of tar oils was dealt with by M. Ab-der-Halden, who described a number of experiments he had carried out with the object of isolating the oils boiling at high temperatures without employing fractional distillation, studying their properties, and discovering their influence on tars in general. M. Chanial gave an account of the arrangements which have been made for the conveyance of coke-oven gas made at Roche-la-Molière to the gas-works at Firminy, which serve that town and also Chambon-Feugerolles, in the department of the Loire. The two places are of some importance—the former having a population of 20,000 and the latter one of 12,000—altogether 32,000 to be supplied with gas. The coke-ovens are of the Koppers type, and the compressed gas is conveyed to Ferminy in a main about 4¼ miles long. Reference has already been made to the experiments carried out by the Paris Gas Company with the object of popularizing the use of gas for the heating of bakers' ovens. These important experiments were dealt with in a paper by M. Rouland, the Managing-Director of the Company, who described the different heaters tested, and gave particulars of their working. Gas is in use in seven bakeries in Paris; and M. Rouland's paper contained a table giving the quantity of gas consumed, and observations on the working of the appliances.

The list of papers for a meeting of the Society would be incomplete without a communication from M. Grebel. This year he had three papers—one in which he suggested that compressed coal gas might be used for driving motors; another describing an arrangement for regulating the supply to upright and inverted incandescent burners at a distance; and the third giving particulars of a burner having two rates of consumption with an inextinguishable pilot-light.

At the meeting of the Society in Paris last year, M. Faucher had a paper on the manufacture of ice in gas-works; but it was not read. The system employed was that of the Raoul Pictet Company, whose plant was illustrated in the paper. The author submitted the subject to the members as one worthy of their attention. It was brought before them again this year by M. Blachette, who introduced to notice the Singrun "*frigorigène*," the recommending features of which he indicated.

M. Versepuy, the Manager of the Toulouse Gas-Works, whose name has been already mentioned, gave a description of the works, illustrated by lantern views; and M. Heeley, of the Compagnie pour la Fabrication des Compteurs et Matériel d'Usines à Gaz, who put up the installation of Woodall-Duckham retorts there, furnished some particulars in regard to their operation. Several subjects were introduced for discussion, including the use of small coke, the washing of clinkers, and the marking of gasholders for the guidance of aviators.

Before concluding this brief indication of the nature of the technical business of the meeting, mention must be made of an interesting lecture by M. Paul Sabatier, Doyen de la Faculté des Sciences of Toulouse, and the holder of this year's Nobel Prize for Chemistry, on the subject of "Catalysis."

[Translations, in full or in abstract, of some of the papers above referred to will be found in another part of the "JOURNAL." The remainder, owing to the great pressure upon our space in consequence of the length of the report of the proceedings in connection with the Jubilee Meeting of the Institution of Gas Engineers, have to be held over for subsequent issues.]

Banquets and Excursion.

The reception accorded to the members by the Compagnie du Centre et du Midi was excellently organized. On the first evening of the meeting, in the Ramier du Château, under the trees on the banks of the Garonne, they were invited to a magnificent banquet and a delightful *soirée*. M. Petsch, the Managing-Director of the Company, proposed the health of the President of the Republic, and greeted the gas engineeers visiting Toulouse—"the rose city"—for the first time. He dwelt in feeling terms on the charms of the city and the fine work of its University, to one of the Masters of which—M. Sabatier, who had been taken into the Institute of France—the members would have the pleasure of listening during their meeting. M. Boutan expressed the thanks of the Society for the hearty welcome they had received, and drank to the City, the University, the Press, and "gas workers generally—from the greatest to the least." The speeches over, by the light of Venetian lanterns decorating gondolas gliding over the Garonne, an "Ode to the Congressists" was sung, and there was a dance of nymphs. Coloured fires were burnt and rockets discharged, and the whole scene called forth most enthusiastic applause. M. Versepuy, who had charge of the arrangements, proved that besides being a perfect manager of gas-works, he is also a very able organizer of a *fête*.

Next day, the banquet of the Society was held in the renowned Hôtel Tivollier. At the close of an exquisite repast, MM. Boutan, Marquisan, Kieffer, Godinet, and Prisse expressed their thanks to the citizens of Toulouse, and also to the Directors and Manager of the Gas Company, for the cordial reception they had given to the congressists.

On Friday, the members had an excursion to Luchon and Superbagnères, where they saw one of the finest panoramas in the Pyrenees.

This review of the proceedings at the meeting must not be closed without acknowledging the assistance rendered by the principal professors of the Faculté in making arrangements for visits, by the ladies who had accompanied members of the Society, to churches, museums, the old houses of Toulouse, &c., and for enabling them to listen to some of the charming old songs of Languedoc and Gascony.

JOINT CONFERENCE OF COMMERCIAL SECTIONS OF THE UNITED KINGDOM.

As has been the custom for several years past, there was held during the annual meeting of the Institution of Gas Engineers last week a joint conference of Commercial Sections of the United Kingdom. The gathering (to which all members of the Institution were invited) took place on Wednesday afternoon, in Caxton Hall, Westminster; and various matters were discussed at some length. At the outset, Mr. EDWARD ALLEN, of Liverpool, the Vice-President of the Institution of Gas Engineers, was voted to the chair; and he was supported by Mr. S. Meunier, of Stockport, the Convener of the meeting, and Mr. H. Kendrick, of Stretford, the Hon. Secretary.

The CHAIRMAN said that, of course, he regretted the President was not there and they could not have his leadership that afternoon; but he was acting wisely in staying away. The duties of the previous day and that morning had been very arduous; and there was still more work to come.

THE MINUTES OF THE LAST CONFERENCE.

The HON. SECRETARY then read the minutes of the conference which took place twelve months ago; and they were confirmed.

GAS-STOVE PRICES.

At the previous meeting, a discussion took place on the question of recent advances in prices of gas-cookers; and it was agreed that a Committee should be formed (composed of one representative of each Commercial Section) to confer with the makers.

Mr. MEUNIER said he was sorry to tell them that, although many attempts had been made to obtain a meeting with the gas-stove manufacturers over the question of prices, they had absolutely proved a failure. It was, he thought, one of the very few occasions on which the Commercial Sections had had to own-up to not having secured the object they had in view.

Mr. J. FERGUSON BELL (Derby) thought it very desirable that the negotiations should be continued. All the members were aware that there had been a very serious increase in the price of cooking stoves and gas-fires. It was quite impossible for the gas undertakings to increase their hire charges—in fact, in many cases they had had to reduce them, or even to do away with them altogether. He was surprised that the gas-stove makers had not met their representatives, to discuss the matter in a friendly way. They did not want the manufacturers to work at a loss; but, on the other hand, they did not wish them to make an exorbitant profit. He hoped there would be no further increase in the prices of cooking stoves or fires, because, if there were, it would, he was certain, be prejudicial to these goods, by reducing the number used. To a large degree the interests of the manufacturers and the gas undertakings were identical. He suggested that the Committee be empowered to continue the negotiations.

Mr. J. H. BREARLEY (Longwood) thought they might possibly strengthen the deputation.

Mr. J. CARTER (Lincoln) supported the resolution in favour of going forward with the negotiations, and seeking an interview with the stove makers which would probably result in satisfying them that the advances last year were reasonable, under the conditions of the moment.

After some further discussion, the resolution was carried unanimously, and further names were then added to the Committee appointed, making the total number about ten.

SELLING COKE.

Mr. MEUNIER dealt with the practice of selling surplus coke by tender, which he said cropped up sometimes, and also with that of giving quotations to coke dealers without making full inquiries. He said the only resolution he could suggest was that the Commercial Sections be asked to go carefully into this important question, and advise their members to make every necessary

inquiry before selling coke to dealers indiscriminately. They were in the sections banded together for mutual benefit and for the help of each individual concern; and they should rely upon each other, and refuse to sell broadcast and anywhere, but insist on being told where the coke was going, and the price at which it was to be sold. If they kept to this, they would get the proper value for their coke.

Mr. CHARLES WOOD (Bradford) seconded the motion, and said he was in favour of making no contracts at all. The only ones he had were with the railway companies. For the last ten years, they had not sent a truck of coke out of Bradford without knowing where it was going, except when it happened to go south of Peterborough or out of the country altogether.

Mr. BELL, in explaining the system he worked on, remarked that it was very desirable to exchange opinions one with another on this important subject.

The CHAIRMAN said they seemed to be quite united on the resolution, which no doubt had a very good foundation.

Mr. CARTER suggested that they should every one of them introduce into every coke contract they made the same strike clause which the colliery people included in coal contracts. It was no use some trying to put it in, unless it was done with absolute unanimity all over the country. He introduced this question a year ago; but it was shelved because, he believed, the Council of the Institution were taking action. What they had done, he did not know; but the sooner they came to a clear understanding on the point, the better it would be for all Commercial Sections.

The CHAIRMAN said that, arising out of what Mr. Carter said a year ago, a great many of them put this clause in their contracts. Perhaps he would move a resolution.

Mr. CARTER said he would propose that the Commercial Sections, or some representatives, be instructed to draw up standard conditions for coke contracts which should be adopted by each Commercial Section in the country.

Mr. MEUNIER seconded this.

Mr. W. E. PRICE (Hampton Court) thought he was right in stating that at the meeting a year ago a set of contract conditions settled by the Council were put in the hands of members.

Mr. R. G. SHADBOLT (Grantham) said that perhaps he could throw a little light on these conditions. They were with regard to coal contracts; and at that time the Committee were considering the question of similar conditions for coke contracts. They did not, however, have time to complete them; and owing to the change in presidency and the *personnel* of various Committees, and the multitude of subjects that the new Committees found themselves faced with, this matter had somehow or other escaped attention. So that by forming a Committee that day they would be taking up work which the Institution Council were unable to carry out.

The resolution was carried.

Mr. H. C. HEAD (Winchester) said he would like to suggest that each Commercial Section should consider means of popularizing the use of coke as a fuel.

Mr. MEUNIER pointed out that the difficulty was that there was too much coke in one spot, and too little in another. How could they equalize it?

COAL CONTRACT CONDITIONS.

Mr. KENDRICK drew attention to the fact that, during his negotiations for coal contracts, he had met with a considerable amount of opposition from one section of the colliery owners, particularly in the Lancashire fields, with regard to the contract conditions which were formulated by the Coal Sales Association of Lancashire and the Lancashire Section of the Manchester Institution, and had since been adopted by the Institution of Gas Engineers.

CANAL NATIONALIZATION.

The CHAIRMAN said the *agenda* included the consideration of the proposal to nationalize the canals. This matter was before the Institution on the previous day; and he did not know that they could carry the matter further now.

Mr. T. BERRIDGE (Leamington) said he thought not. It seemed to him, however, that they ought all of them to do what they could to strengthen the hands of the Waterways Association, by pressing on Members of Parliament the importance of making the waterway referred to. If it ran from Liverpool to London and from Hull to Bristol, it would pretty well get to all the kingdom, because there were branches brought in. It was important that they should in this matter be placed in a similar condition to the Continent.

The CHAIRMAN said the reason for putting the matter on the *agenda* was that each member should make it his business to get the undertaking he represented to send a petition to Parliament. They might perhaps make a note on the minutes that the matter was referred to, and that the meeting was entirely in sympathy with the views of the Waterways Association.

LIGHTING OF GOVERNMENT BUILDINGS.

Mr. OCTAVIUS THOMAS (Pentre) said the question of the lighting of public buildings was raised in the Wales and Monmouthshire Commercial Section last July, owing to the fact that some new buildings had been lighted by electricity without considering the advisability of using gas. Later on, an article appeared in the "JOURNAL OF GAS LIGHTING," where it was stated that the Board of Trade had definitely settled that all Labour Exchanges, where possible, were to be lighted by electricity. His section thought it time the question was brought forward, to see if something could be done.

Mr. F. W. GOODENOUGH (London) said he did not think it was a fact that there was any decision of the Government that electricity should be installed wherever possible in Labour Exchanges, because at the present moment the fitters at the Office of Works were putting in gas for the lighting of two Labour Exchanges, where electric cables were outside the door. It had not been found in London that there was any general decision to take electricity and not gas. He suggested that the matter should be referred to the British Commercial Gas Association to take any action they might think advisable.

Mr. SHADBOLT pointed out that the Parliamentary Committee of the Institution had the matter in hand, and had found it impossible up to the present to trace any definite instruction of the kind referred to. In the face of this, was it advisable to ask any other body to take the question up?

Mr. GOODENOUGH said if it was the fact that the Institution and the Gas Companies' Protection Association were dealing with the matter, they did not need a third body.

Mr. CARTER said all possible was being done at the present time; and they might safely leave the matter there. He repeated what he said recently at Cambridge—that an order had been issued from the central office in Birmingham to the effect that where electricity was available no gas should be laid in Labour Exchanges.

Mr. SHADBOLT said it was only due to Mr. Carter to say he had taken a lot of trouble in the matter.

Other business was then transacted, and the Convener and Hon. Secretary were re-appointed.

The proceedings concluded with a vote of thanks to Mr. Allen for presiding; the use of the room being also acknowledged.

"Pharos" Lamps in Paris.

In a chatty communication to the "Journal de l'Eclairage au Gaz" a short time ago, M. Grebel referred to the perturbation of the electricians at the progress that was being made with compressed incandescent gas lighting, and remarked on the installation, in various parts of Paris, of flame arc lamps so as to compete with the "Graetzin," "Pharos," "Colonia," and other gas-lamps. After the publication of his communication, he received a letter from M. Delamotte, the Managing-Director of the French Heat and Light Company, confirming the observations made, and conveying the information that, notwithstanding the efforts of the electricians, the high-pressure gas-lamps continued to increase in numbers. M. Delamotte was not in a position to give particulars of all the lamps of this class; but, so far as those of the "Pharos" type were concerned, he gave a list of those actually installed in Paris, and it is reproduced by M. Grebel in the current number of our French contemporary already mentioned. They number 354, divided as follows: 173 of 4000-candle power, 91 of 2000-candle power, and 90 of 1000-candle power. The finest show of these lamps is on the Boulevard Montparnasse, where there are 142 three-burner lamps of 4000-candle power each, and 24 lamps, with a similar number of burners, of 2000-candle power. On the Place de la République there are 20 three-burner 2000-candle power lamps and 52 two-burner lamps of half this power; while in the lighting of the Place de la Concorde, 38 two-burner 1000-candle power lamps are employed. M. Grebel remarks that these figures prove that the extension of lighting by compressed gas is not coming to a standstill, notwithstanding the recent "spurt" on the part of electricians. Gas people never had any doubt about it.

Accident to Mr. King Hiller.—The friends of Mr. H. King Hiller will be sorry to learn that he met with a rather bad accident on Monday last week. When out with a motor cycle and side-car, he turned a corner too suddenly, and sustained a fracture of the leg.

The Late Mr. William Fox.—The late Mr. William Fox, whose recent death at the age of sixty-six was briefly recorded in the "JOURNAL" last week, was senior partner in the firm of Messrs. Fox, Bateman, and Fox, of Westminster. His engineering training commenced in 1865 with Messrs. J. Watt and Co., of Soho, Birmingham. After this he was pupil for three years to Mr. J. F. La Trobe Bateman, F.R.S., afterwards President of the Institution of Civil Engineers. During the time, he was engaged in office and field work. His occupation in the latter connection included some months, in 1869, spent on the Manchester Corporation Water-Works in Longdendale. Subsequent to the termination of his pupilage, he was employed by Mr. Bateman from 1871 to 1876. He acted as Engineer-in-Charge of the construction of the water-works for Aberdare, which cost upwards of £30,000. Between 1873 and 1876 he was Engineer-in-Charge of the Colne Valley Water-Works and extensions, which cost over £85,000. He was also connected with the planning and construction of water-works at Newcastle and Gateshead, at Forfar, and at many other similar undertakings at home and abroad. In 1890, he commenced practice in Westminster, and engaged in consulting and parliamentary work. He was admitted to the Institution of Civil Engineers as a member in 1877, and was for some time a member also of the Institution of Mechanical Engineers.

ELECTRICITY SUPPLY MEMORANDA.

THE Bill promoted by the Incorporated Municipal Electrical Association, as already mentioned in the "Memoranda," has been revived. There is little change from the previous form. It is proposed by it to give any municipal electric undertaking power to provide wiring and fittings, and companies are included in the hope of getting subscriptions from them. Permission is also asked for electrical undertakings to expend money on advertising as they may think fit, which would remove the objection that some local authorities have to subscribing to joint effort owing to the fear of surcharges. There is a provision regarding stand-by supplies; and for the authorization of the payment of delegates' expenses in connection with conferences and meetings, and of purchase money for reports of proceedings, &c. The promoters want to carry surplus revenue to a fund for working capital—provided that the fund does not at any time exceed a sum equivalent to one-half of the gross annual revenue of the undertaking. Then a perpetual authorization for borrowing powers is sought, up to one-tenth of the amount expended on the purchase of lands and construction of works prior to the expiration of the period of three complete years after working of the undertaking has commenced, or one-tenth of the amount authorized to be borrowed for the purposes of the undertaking prior to the expiration of that period, whichever amount shall be the larger. Repayment is to be within ten years from the date of borrowing. There are minor and customary clauses which need not be here noticed. The promoters have been unable to obtain the countenance of the Institution of Electrical Engineers and the British Electric and Allied Manufacturers' Association. The Hon. Secretary of the Municipal Association (Mr. H. Faraday Proctor), in making this announcement, does not say anything about the adherence to the project of the Electrical Contractors' Association, and the various organizations of the gas industry. Some of the latter represent concerns interested in electricity. This must be an oversight on the part of Mr. Proctor.

Resuscitated Bill.

The members of the Watch Committee of the Sheffield Corporation, who are evidently in charge of the public lighting of the city, want some more information. They have decided to engage Mr. Haydn Harrison, a Member of the Institution of Electrical Engineers, at an inclusive fee of 100 guineas, to prepare a report on the question of the relative cost and efficiency of gas and electric light for street illumination. Why spend 100 guineas when particulars from some of the reports that Mr. Harrison has previously prepared have been published, and so are available to the Sheffield Watch Committee? In all those that we have seen, and upon certain of which we have commented, the cost and efficiency (according to Mr. Harrison) are both favourable to electricity. Of course, gas men entertain other views. Perhaps the Watch Committee will favourably consider the expenditure of 100 guineas on a gas expert as well so as to show their independence. If there are any reports in which gas has been made to come out on top at the hands of Mr. Harrison, a reference to them will greatly oblige, as we should sincerely like to read and inwardly digest them, and perhaps have them framed in order to preserve what to us would be novelties of the very first order. But probably Mr. Harrison will find Sheffield a harder nut to crack than some other towns, in view of the cheapness of gas there. It is some time since the writer of the "Memoranda" was in Sheffield. But it is hoped that the street lamps or part of them have, prior to this engagement of Mr. Harrison, had some of the latest high efficiency inverted gas-burners applied to them. We know of some towns where we should say it would serve the gas undertaking right if the local authority did suddenly bring in Mr. Harrison to report to them on the cost and efficiency of gas and electric lighting. The management of these undertakings would do well, and would be studying the future interests of their concern if they engaged a gas-lighting expert to advise them what they should do, if they are incapable of forming correct judgment on their own account. However, we shall be glad to read the Sheffield report of Mr. Harrison, to see how he enlightens the rulers of the city.

Almost a Foregone Conclusion.

The "Electrical Times" does not think that the sellers of gas-cookers really believe all they say regarding them. It judges the gas industry very much by the standard set by the doings of the electrical industry. The writer of "Cooking and Heating Notes" in our contemporary has come across a pamphlet, which he says has been issued by a company making gas-stoves and cookers; and in it, among other choice references to competing designs, are such phrases as: "In the ordinary gas-cooker noxious gases are liberated chiefly through the incomplete combustion of the gas, and the meat hangs in this poisonous atmosphere." "The ordinary gas-cooker smells vilely as every householder who has used one knows." We should like the name of the company responsible for the circulation of such trash as this. The "Electrical Times" professes to believe the statements are true. We are sorry for the intelligence of the "Electrical Times." Our contemporary imagines that, because one firm making gas-cookers (we are not aware whether it is a recognized firm, or one only operating on the fringe of the gas-stove industry, and hoping to get business by the methods of the cheap-jack) choses to indulge in misrepresentation, therefore the gas industry is becoming alarmed at the "rapid" strides made by the electric-cooker. If it pleases our contemporary, we hope it will go on indulging the senseless belief. Then another queer piece of imagination is transferred into words in this sentence: "They [meaning the gas-stove makers] are now endeavouring frantically to redesign their crude cookers so as to get some at least of the advantages of electrical operation." We are afraid we have missed seeing any of this "frantic" effort. We would ask the "Electrical Times," if it cannot be sensible in dealing with these matters, to at least be kind, and to refrain from rolling "gas people" all up into one bundle of incompetents. We are afraid that the so-called "gas man" who wrote the absurdities contained in the circular referred to is not a gas man at all, and certainly knows nothing of what he is talking about, as proved by his allusions to "noxious gas" and "poisonous atmosphere." If he is a gas man, then he is not—thank goodness!—the only pebble on the beach.

Imagination.

"Imitation is the sincerest form of flattery;" and the "Point Fives" will be directly puffing themselves out immensely, if their ranks continue to increase much more. The main idea of the "Point Fives," as those of our readers will know who have followed the inception and gentle rise of this conservative little body, is to prevent the necessity of duplicate wiring and meters where electricity is also used for purposes other than lighting, by charging electricity consumers a fixed percentage on the net rateable value of dwellings or other premises and 0·5d. per unit for all electricity consumed, no matter the purpose. The Manchester Corporation Electricity Committee have adopted the system, with percentage of 12½ on the rateable value; so that Mr. S. L. Pearce, the City Electrical Engineer, may now congratulate himself (or otherwise as he thinks fit) on his eligibility for the "Point Fives" Club. A correspondent in the "JOURNAL" a fortnight ago called attention to the question of the charge of 0·5d. per unit for purposes other than lighting, and mentioned seven places in which 0·5d. has been adopted. Of course, the charge is not 0·5d., but that *plus* the fixed payment (divided by the number of units consumed)—the greater the number of units used, naturally the lower the average price. The seven places mentioned, too, only represent about half the number of 0·5d. towns. The list includes: Accrington, Barnes, Bradford, Carlisle, Luton, Manchester, Poplar, Reading, St. Marylebone, Sheffield, Southampton, Sunderland, West Hartlepool, Wrexham, York. We are not sure whether West Ham is entitled to inclusion in the list.

More "Point Fives."

Brighton is grievously disappointed. It was expected that the electricity concern would last year yield a surplus for appropriation in aid of the rates; and the concern has failed the ratepayers, as correctly it should do in this respect, if it were not that the fact shows a drop off in prosperity. The accounts of the year to March 31 show a net profit of only £1406, compared with £8450 the previous year. It is seen that the revenue from all sources decreased by £2772; the total receipts, in round figures, being £96,197. On the other hand, the expenditure increased by £4430. Among the items of additional outlay were rates and taxes, which exceeded by £1231 the previous year. Coal, too, exhibits an advance of £2102, or an average of 2s. 9½d. per ton. Notwithstanding that the quantity of coal consumed per unit was reduced from 6·26 lbs. to 4·18 lbs., the cost advanced from 0·33d. to 0·38d. per unit. As to the drop in revenue, although there were 307 new services connected, private lighting sales show a reduction of 30,227 units; private power, of 36,520 units; and the tramways, of 112,433 units. The Engineer (Mr. J. Christie) does not appear highly exultant over the position; but apparently he looks to cooking to help him to mend matters. He mentions two cooking installations existing in Brighton; and it is understood that he is now recommending that, in the next applications for sanctions to loans, £3000 or £5000 shall be included for the purchase of cooking apparatus. In the report, too, we see an incidental reference to the collapse of the supply on Jan. 3, which we rather fancy was the occasion when Mr. Christie was in the midst of a lecture, and had to bolt in the darkness from the room and on to the electricity station to ascertain what was amiss. Mr. Christie must be glad to see the end of the financial year 1912-13.

Brighton Disappointed.

Mr. Christie's reference to 4·18 lbs. of coal having been used per unit of electricity sold, inclusive of transmission, transformation, and distribution losses, reminds us of the question as to the thermal value obtained respectively from coal by electricity and gas processes. Taking only 14,000 B.Th.U. (instead of the 14,800 usually reckoned for steam coal) the 4·18 lbs. used per unit represent 58,520 B.Th.U. The unit generated from this is equal to 3440 B.Th.U. (to give the highest value electrically claimed). A pound of coal (14,000 B.Th.U.) will produce 5 cubic feet of gas; 4·18 lbs., 20·9 cubic feet—say, 21 cubic feet, which are equal to 10,500 B.Th.U., at 500 B.Th.U. per cubic foot, against 3440 B.Th.U. for the unit of electricity. That is not all. The coke, the tar, and the pitch

Thermal Value from Coal.

produced account for all but a small percentage of the remainder of the thermal value in the coal. This is interesting, and it is worth consideration by economists, as well as by those electricians who deceive themselves as to the generation of electricity being an economical use of coal.

Hastings Profits and Public Lighting.

Congratulations to the Hastings Electricity Department. It made in the last financial year the magnificent net profit of £556, against £91 the previous year. The total receipts have improved from £20,608 to £22,327. Among the changes in the items constituting this sum, we see the receipts from the sales of current have increased from £14,428 to £15,493; and street lamps have returned an addition in the shape of the difference (£569) between £5312 and £5881. There seems no chance yet of any reduction of price to the private consumers, though some of them are paying 6½d. per unit, as compared with 2d. per unit for the metallic filament lamps used in public lighting. There is also no chance of any contribution to the rates on the part of the undertaking. So long, however, as the Electricity Department returns to the ratepayers the £15,638 of which it has robbed them in order to make up its own shortcomings, it need not trouble about a contribution to the rates, because it is against sound finance in municipal trading—just as unsound as is the habit of some municipalities of making the ratepayers pay more for an inefficient system of electric street lighting, because they happen to control the electrity concern. Hastings possesses one of these Councils. In the conversion of gas-lamps there, we find some interest, as the Council's action is dressed up in the most flagrant humbug. At the meeting at which the accounts of the department were presented, it was stated that, although for the public metallic filament lamps only 2d. per unit is charged, the Corporation are paying 6 per cent. more per lamp than they were paying for the corresponding gas-lamps. Now read this little piece of humour put forward to give the ratepayers more satisfaction. The remedy the Committee are proposing to apply is to increase the light of the electric lamps by 6 per cent.—not all of them, but on an average one in seven—that is to say, one in seven lamps is to be increased from a 50-candle power unit to one of 72-candle power—the lamps being placed where most required. Of all the grandmotherly things of which we have heard in connection with public electric lighting, this "takes the cake." Even then it does not mean that the lamps will be giving the light that could be obtained by modern gas-lamps at the price now being paid for the electric lamps. The difference represents a robbery of the ratepayers. The 2d. per unit charged for the metallic filament lamps (4d. being the price for the current used by the arc lamps) is still put forward as the salvation of the Electricity Department. It is said that this 2d. per unit yields a profit. It is on this invention that electric mains are extended. The profit per lamp converted is put at 30s. per lamp. If we take 640 as representing the number of lamps in use last year, 30s. per lamp should mean £960. But the total profit of the whole working of the department was only £556! The lamps therefore yielded about £400 less than they should have done, and there was no profit on the units at 6½d., 4⅞d., and 4½d.! Profit therefore can be made at 2d. per unit, but not at the higher prices. "No Mr. Ferguson and members of the Hastings Electricity Committee, your assertions regarding those 2d. units do not find confirmation in the accounts; and it is only a right thing that you should make a clean breast of the absurd muddle into which your own claims have placed you."

BENZOL FROM COAL GAS.

THE extraction of benzol from coal gas was recently dealt with in the Engineering Supplement to "The Times," by an engineering correspondent, under the heading of "Gas Engineering," which has formed the subject of several articles lately. The writer's remarks were as follows.

Theoretically, the deterioration produced in the quality of gas by washing the benzol out of it would appear to introduce no very serious difficulty; for in London gas, as it is to-day, the benzene content is probably not more than 0·7 per cent. on an average. The calorific power of benzene and its homologues is, however, higher than that of any other constituent of town gas, and amounts to about 3800 B.Th.U. per cubic foot. Hence, to debenzolize the gas would be to deprive it of perhaps no more than 25 B.Th.U.; this reduction on a mean gross value of 550 B.Th.U. amounting to nothing very considerable.

A further factor, however, enters into the question, and that is illuminating power. In a series of tests recently conducted on London coal gas which was scrubbed in a manner similar to that carried out for benzol recovery in coke-oven works, remarkable and somewhat disconcerting results were obtained. Gas which previously showed a brilliancy of about 14 candles was so deprived of its light-giving hydrocarbons that no test was possible on the ordinary table photometer with the standard No. 2 "Metropolitan" argand burner. The naked flame was certainly not deprived of its illuminating properties altogether; but the quality of the gas was so reduced as to render it unfit for consumption in the ordinary type of luminous jet. In this case the solvent used (creosote) was the same as that employed for the purpose with coke-oven gas. There is little doubt that, in addition to bringing down the benzene constituents, no little havoc was played with other hydrocarbons, such as those of the acetylene and the olefine series. In order to avoid this, and to ensure the extraction of benzene alone, absolute alcohol was then used as a solvent, while the gas was afterwards bubbled through water to ensure that no alcohol went forward to the flame. In this instance, the deterioration in illuminating power was not so striking, though sufficiently great as to render the flat flame practically unserviceable. It must be borne in mind, however, that, on account of expense, the employment of alcohol would not be possible on a commercial scale.

MIDLAND JUNIOR GAS ASSOCIATION.

THE Annual General Meeting of the Association was held at the Technical School, Birmingham, on the 12th inst. In the absence of the President (Mr. F. Shewring), the chair was taken by the Senior Vice-President, Mr. W. H. JOHNS, of Birmingham.

The minutes of the previous meeting were read, confirmed, and signed; and apologies for absence, received from the President and from Mr. A. Hancox, of Malvern, were read.

The HON. SECRETARY (Mr. W. J. Pickering, of Birmingham) then presented the annual report. In it the Council congratulated the members on having had a successful session, and one full of interest. The number of honorary members was 20; of ordinary members 190—the latter being a decrease of one. The Association were indebted to the President (Mr. F. Shewring) for his able address, and for the efficient manner in which he had discharged the duties of his office, though living some distance from Birmingham; to the readers of papers, for the maintenance of previous standards; and to the directors of the various undertakings to which visits had been paid, for their kind invitations and hospitality. The indebtedness of the Association was also expressed to Professor Burstall, M.A., for his lecture on "High-Pressure Gas;" and the Committee of the Birmingham Municipal Technical School were thanked for their kindness in granting the use of a room for the meetings. The work of the session was noticed in detail; included therein being visits to the Wolverhampton Gas-Works and to the Droitwich Gas-Works, Salt Works, and Brine Baths. [The joint visit of the English Junior Associations to Sheffield took place on the 14th inst.] Several removals and advancements of members of the Association occurred during the session. The Council concluded by expressing the hope that every member would do his best to promote the welfare of the Association by attending the meetings and visits whenever possible.

The HON. TREASURER (Mr. G. C. Pearson, of Birmingham) presented the balance-sheet. It showed that the expenditure had exceeded the income by £15 1s. 4d.; and the balance in hand of £48 16s. 0½d. was consequently reduced to £33 14s. 8½d. Mr. Pearson explained that the financial position of the Association was practically the same as at the end of the previous session, as since the audit a few further subscriptions had been received. This was quite a satisfactory state of affairs, as the Association did not require any considerable capital, but only needed to be self-supporting.

On the motion of the CHAIRMAN, seconded by Mr. F. J. WARD, the report and balance-sheet were adopted.

A hearty vote of thanks was accorded the Hon. Auditor (Mr. J. H. Hardy, of Coventry) for his services.

The CHAIRMAN announced that the Council had elected Mr. G. C. Pearson, of Nechells, Birmingham, as the new Junior Vice-President.

The following officers were elected for next session:—

Hon. Secretary.—Mr. W. J. Pickering (re-elected).
Hon. Treasurer.—Mr. H. E. Stone, of Nechells, Birmingham.
New Members of Council.—Mr. T. Brooke, of Nechells; Mr. G. F. Twigg, of Derby; and Mr. F. A. Jenkins, of Leamington.

The new members of Council were in place of Messrs. P. C. Balcon, F. J. Ward, and T. H. Poulson.

A hearty vote of thanks to the officers, for their services during the session, moved by the CHAIRMAN, seconded by Mr. WORRALL, and heartily accorded, concluded the meeting.

Practical Hints on Road Tarring.

A leaflet entitled "Notes upon Tar Treatment of Road Surfaces," giving the elementary principles in road-tarring work, has just been issued by the Roads Improvement Association. It has been prepared for the information and guidance of men actually engaged in tarring work on the road who do not usually have access to the various comprehensive technical publications upon the subject. The unsatisfactory results from the tar treatment of roads often complained of by road users have been traced, in many cases, to the non-observance of the elementary principles in this work. The leaflet deals with: (1) The suitability of a road for tar treatment; (2) the preparation of the surface; (3) the kind of tar to be used; and (4) the application of tar to the road and its subsequent gritting. The leaflet will be found interesting to laymen as well as to the men actually engaged in road-tarring work; and the Secretary of the Roads Improvement Association (Mr. Wallace E. Riche, 15, Dartmouth Street, Westminster, S.W.) will, on request, supply copies at 2d. each, post free.

THE WALTHER FELD PROCESS FOR THE MANUFACTURE OF SULPHATE OF AMMONIA.

In the "Journal" for last week we gave a translation of the first part of a paper on this subject, by Signor A. Pacchioni. The first section dealt with the general working of the process, and the plant installed at the Königsberg Gas-Works. We now give the second and concluding part of the paper, which treats of the sulphate produced by the system, and compares the process with that of Burkheiser.

Aspect and Composition of the Sulphate.

The sulphate of ammonia produced at Königsberg is in form of crystals larger than those obtained in the ordinary process, and of a slightly grey colour. After being exposed to the air for some time, it acquires a peculiar red colouration. It is, however, a good salt, which, on analysis, has given as much as 99·44 per cent. of sulphate of ammonia, with 25·63 per cent. of ammonia. The average is 96 to 98 per cent. of sulphate and 25·4 per cent. of ammonia.

The salt, after leaving the centrifugal washer, is spread out on a dryer situated in an unoccupied part of the purifier house. The dryer simply consists of a floor of iron plates, shut on the outside with boards, and heated below by steam pipes. In a few hours the salt is dry, and is immediately put into bags and thus stored, even for long periods, without risk of injury to the packing, as the sulphate is perfectly free from acid. With regard to its colour, the cause cannot be specified with absolute certainty. Researches made with a sample of Königsberg sulphate demonstrated that treatment of the sulphate with distilled water leaves an insoluble residue, more coloured than the primitive material, and a yellowish solution. The colour of the solution seems undoubtedly due to sulphate of iron, and that of the residue is of organic origin. The presence of sulphate of iron could be explained by the formation of two acids, $H_2S_2O_3$ and $H_2S_4O_6$, which, though in the nascent state, may combine directly with ammonia; moreover they may attack, slightly, the iron of the plant, and produce traces of sulphate of iron more than sufficient to cause this colouration. However, from the fact that neither the Pelouze nor the cyanide washer worked well (the latter, for example, only absorbed half the cyanides of the gas) we may infer that this residue originates in anthracene or pyridine or phenol derivatives or sulphocyanides.

Results Obtained at Königsberg.

The Königsberg plant, though on a large scale, is only an experimental plant. Consequently there is a deficiency in the number of the appliances and their capacity, which are certainly insufficient for the treatment of all the gas produced at the works. At the time of my visit, for example, there was only one Feld washer working, the other being under repair; and it is easy to understand that the success of the system depends on the efficacy of washing the gas. However, though imperfect, it has given excellent results as regards the absorption of ammonia, and, we may say, encouraging ones in the case of sulphuretted hydrogen.

The following table contains some results taken from the daily reports of the analyses made at Königsberg to ascertain the working of the Feld washers. By way of explanation I may add that the figures refer to 100 cubic metres [3532 cubic feet] of gas, and they were taken during working of one or the other or both of the Feld washers.

1912.		Inlet.	Outlet. I.	Outlet. II.	Absorption per Cent.	Temperature of Gas at Outlet. Centigrade.
Feb. 1.	NH_3	316·3	85·3	33·4	89·5	..
	H_2S	1430	1255	1238	14·3	..
Feb. 16.	NH_3	352	68	4	99·0	27·5°
	H_2S	1300	1090	1000	22·1	..
March 15.	NH_3	290·7	..	50·5	82·6	24°
	H_2S	1477·1	..	1388	6·0	..
April 1.	NH_3	354	..	7·8	97·70	23·5°
	H_2S	1600	..	1511	9·5	..
May 17.	NH_3	270	17·4	..	93·5	33°
	H_2S	710	97·5	..	30·0	..
June 11.	NH_3	425	17·8	..	95·8	35°
	H_2S	1024	800	..	21·9	..

As can be seen, absorption of ammonia is almost complete, while less than a third of the sulphuretted hydrogen contained in the gas was extracted on the day of the best working. It will also be seen that the absorption of ammonia is absolutely independent of temperature of the gas and air—a very important point. It is therefore certain that the application of the Feld process, although in a partial degree, has resulted in an improvement at Königsberg in the recovery of ammonia. In fact, whereas of late years the following results had been obtained,

	Kilogrammes.		Kilogrammes.	
1909-1910	1·38	NH_3 =	5·52	sulphate per ton of coal
1910-1911	1·73	,, =	6·92	,, ,, ,,
1911-1912	1·93	,, =	7·72	,, ,, ,,

during the last few months, since the Feld washers have been working continually and more regularly, the following were obtained:

	Kilogrammes.		Kilogrammes.	
March	2·56	NH_3 =	10·24	sulphate per ton of coal
April	2·13	,, =	8·52	,, ,, ,,
May	2·56	,, =	10·24	,, ,, ,,

With regard to sulphuretted hydrogen, I inquired why absorption was much less than that claimed for the system, and too little compared with that existing in the gas. Without disputing the fact that there is, generally, in the gas only as much ammonia as is necessary to combine with about a third of the total sulphur, it was pointed out to me that, as a matter of fact, in a plant constructed on this system it was necessary to utilize the same ammonia over and over again to neutralize all or nearly all the sulphuretted hydrogen present.

In the tests made at the experimental laboratory of Hönningen, it was possible to fix 89 per cent. of the sulphuretted hydrogen contained in a given gaseous mixture with polythionate of ammonia. Considering this matter without prejudice, it is not clear why this should not also be attained even in an industrial plant, provided with abundance of means for washing; and, personally, I am inclined to the opinion that this result ought to be attained. But it is a fact that at Königsberg not more than 30 per cent. of the sulphuretted hydrogen has yet been extracted, and even this only in certain particular conditions not yet ascertained.

Comments on the Königsberg Plant.

Mr. Ernst Kobbert, the Manager of the Königsberg municipal works, in addition to giving permission to examine the existing plant in his works, was kind enough to state his opinions on the subject and describe what he intended to do in the future. He considers that, with three Feld washers, all other ammonia washers, and all purifiers, would be superfluous, and that the production of gas increases when a regular Feld plant is installed. He regards as one of the great advantages of the Feld process the possibility of eliminating the ammonia, whatever the temperature of the gas (a very interesting point for hot climates), and in the case of having to treat large volumes of gas which cannot be cooled by the ordinary methods. According to his estimate, the total economic advantage of the new Königsberg plant would be 6½d. per metric ton of coal distilled. The final opinion of Mr. Kobbert is that the Feld system is excellent as regards ammonia, but still rather unreliable for sulphuretted hydrogen. The proof that he is convinced of the good working of the Feld process is the proposal he made to the Königsberg municipality for an installation of further plant of this type. The new plant would be constructed on an unoccupied site in the purifier house, on a space of about 49 feet by 81 ft. 6 in., and would suffice to treat 250,000 cubic metres (nearly 9,000,000 cubic feet) of gas daily. The building in question would have three stages—viz., a basement for the precipitation basins, a ground floor for the Feld washers, and a first floor (partially roofed over) for the vats and driving gear.

There would be two sets of three Feld washers—three of the same dimensions as usual, and three larger ones, 6 ft. 6 in. by 21 ft. 4 in., also a certain number of vats, about 10 ft. by 10 ft., for the regenerators, finishers, neutralizers, &c. According to the proposed arrangement, the two sets of washers would be placed in series, the gas passing through one after the other, while the liquid would be equally divided among them. Thus the gas and liquid would not flow in opposite directions—a system which does not appear to be justified by any reason.

Working Costs.

Thanks to the courtesy of Mr. Kobbert, I was able to examine a detailed account of expenditure and receipts with the old and with the new plant. The estimate is based on a distillation of 60,000 metric tons of coal per year and upon the following prices (1 mark = nearly 1s.):

Concentrated ammoniacal liquor	0·92	mark per kilogramme
Prussian blue (Fe_7Cy_{18})	0·151	,, ,,
Sulphate of ammonia	1·18	,, ,,
Price of ammonia from sludge	0·74	,, ,,
Sulphuric acid	8·0	,, 100 kilogrammes
Sicilia sulphur	9·0	,, ,, ,,
Spent oxide with 50 per cent. S.	5·0	,, ,, ,,

These are the Königsberg prices. Without going into details, I shall merely give the results of both systems.

Old System.

Produced 1·73 kg. of ammonia and 0·44 kg. of blue per ton of coal distilled, consequently a total of

108·5	tons of ammonia at 0·92 mark per kg. =	99,820	marks
27·5	,, blue at 0·15 ,, ,, =	4,200	,,
		104,020	marks

New System.

Produced 2 to 3 kg. of ammonia and 0·9 kg. of blue, representing a total of

140 tons of sulphate at 1·18 marks per kg. =	155,740 marks
8 ,, ammonium cyanide at 0·74 mark per kg. . . . . =	5,920 ,,
56 ,, blue at 0·15 mark per kg. . . . =	8,400 ,,
	170,060 marks

Thus the profit would be:

Old System.

Receipts		104,020 marks
Working expenses	37,811	
Interest, amortization, and maintenance.	27,842	65,653 ,,
Net profit		38,367 marks

New System.

Receipts		170,060 marks
Working expenses	55,547	
Interest, amortization, and maintenance.	36,126	91,673 ,,
Net profit		78,387 marks

The increase of net profit per ton of coal distilled is therefore

$$\frac{78,387 - 38,367}{61,559} = 0{\cdot}65 \text{ mark.}$$

These figures, accurate for Königsberg, would not apply to our works. In fact, if from the total expenses of 55,547 marks we deduct those for treating the cyanides—viz., 9122 marks, there remains an expense of 46,425 marks, which reduces the total to 82,551 marks to produce 4 × 140 = 560 tons of sulphate, or a cost per quintal of 14·74 marks, representing about 14 per cent. of the sale price.

This cost of manufacture corresponds approximately to the average with the old system in Italian works. The cost of manufacture represents at most 30 per cent. of the sale price. We may therefore conclude that in large gas-works the cost of manufacture by the two systems is the same or nearly so. In medium works the necessity for special workmen and a chemist would increase expenses to such an extent as to make it out of the question.

A Comparison with the Burkheiser Process.

Having reached this point, the question arises whether the Feld process will be more or less profitable for gas-works than the Burkheiser system. The latter, as we know, is on trial in the experimental laboratory of the Tegel Gas-Works, Berlin, because nothing is yet known about the extensive plant which, it was reported, is being constructed at a large English gas-works, and that of the Flemalle works, and coke-ovens in Liége. We merely know the latter plant has been abandoned after many vicissitudes.

According to the patent of 1908, and what was published some time ago, the Burkheiser process consisted in the following operations:

(*a*) Purification of the gas with granular iron oxide manufactured in a special way.
(*b*) Regeneration of the mass by blowing air into it, and production of sulphur dioxide.
(*c*) Formation of ammonium bisulphite, by the action of sulphurous acid upon the sulphite of ammonia, in suitable washers.
(*d*) Conversion of the bisulphite into sulphite by the action of purified gas, but yet containing ammonia, in a washer like the preceding.
(*e*) Oxidation of the sulphite of ammonia into sulphate.

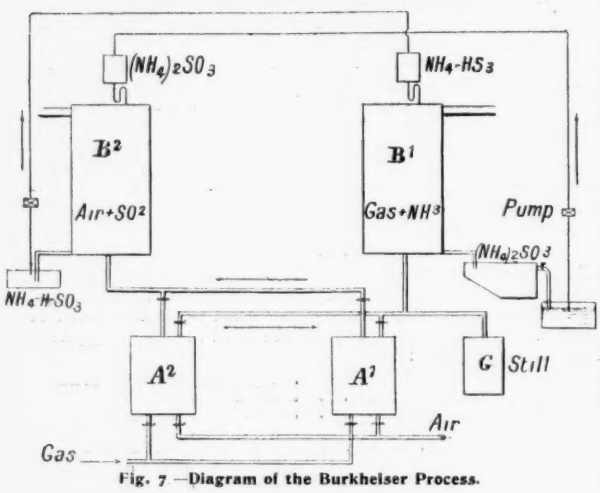


Fig. 7.—Diagram of the Burkheiser Process.

The arrangement of the various parts of the plant should be that given in fig. 7, and the essential reactions of the whole system are:

In the purifiers $\begin{cases} Fe_2O_3 + 3H_2S = 2FeS + S + 3H_2O \\ 2FeS + O_7 = Fe_2O_3 + 2SO_2 \end{cases}$

In first washer $\begin{cases} 2NH_3 + SO_2 + H_2O = (NH_4)_2SO_3 \\ (NH_4)_2SO_3 + SO_2 + H_2O = 2\,(NH_4)HSO_3 \end{cases}$

In second washer $(NH_4)HSO_3 + NH_3 = (NH_4)_2SO_3$

Practically the salt obtained consists of two-thirds sulphate of ammonia and one-third sulphite, which Burkheiser proposed to transform into sulphate by oxidation in special apparatus, sublimating the sulphite at a temperature below 100° C.

$$(NH_4)_2SO_3 + O = (NH_4)_2SO_4.$$

However, the process placed in the hands of Professor Drehschmidt, the distinguished Director of the Chemical Laboratory of the Berlin municipal gas-works, was subsequently greatly modified. The special iron oxide is not now required, and purification is effected in scrubbers, with iron oxide in suspension in the washing liquid—thus practising continuous purification in closed vessels. The oxide, when exhausted, is treated in a special furnace to obtain sulphur dioxide. The ammonia is separated in two stages—first in a saturator in which, most of the ammonia being absorbed, the salt is formed; and finally in a scrubber, to extract all that remains. Henceforth there will be no sulphite oxidizing furnace, as it has not been found to answer the purpose intended. Even with these changes the Burkheiser process is not definitely established—being still in a transition stage. However great may have been the expectations, they have not yet been realized, whereas the Feld process is established by practice, and can, under certain conditions, be classed without fear among the current methods of gas-works. For this reason, no real comparison can be made between a technical process already made practical, and another which is only technically planned out.

Conclusions.

From what has been said, and from the results of an experimental plant (as is that of Königsberg), I think that the following conclusions may be drawn.

1. That the Feld process effects perfectly the extraction of ammonia from lighting gas.
2. That there is, as yet, some doubt about the possibility of complete elimination of sulphuretted hydrogen, although laboratory experiments have demonstrated its possibility.
3. That, without reckoning the possible economy in purification of the gas, as it cannot yet be precisely given, the cost of producing sulphate of ammonia, according to the data we have, would be about the same as at present.

Regarding the applicability of the system, I consider

1. That it will undoubtedly be applicable in large gas-works, coke-ovens, Mond-gas plants, and, generally speaking, in cases where large volumes of gas containing ammonia are treated.
2. That it will be so in certain circumstances in average-sized works.
3. That it will certainly not be so in small works, because often they have not the means for direct washing of the ammoniacal liquor, and they are less likely to have them when a chemical analysis is necessary. Steam and motive power, also, are not always at their disposal.
4. That, on the contrary, even for average and small works direct sulphatation will be more convenient, as it has been shown to be technically possible and economically advantageous.

Garcke's "Manual of Electrical Undertakings," for 1913-14.

We have received from the Electrical Press, Limited, a copy of this work, which has just been published. It is the seventeenth annual volume, and contains statistical and general information relating to about 3000 electrical undertakings, compared with 200 in the first volume, which was issued in 1896. The contents are divided into seven sections, the first four containing a record of electric companies formed under the Joint-Stock Companies Acts and of electric undertakings belonging to local authorities in the United Kingdom, and those in the Colonies and the British Possessions. Comparative summaries, covering the financial results of electric lighting and traction undertakings, are given; and comprehensive statistics relating to all sections of the electrical industry have been brought up to date. Section V. is a directory of officials, members of electric lighting and tramway committees, and electrical contractors; and it contains upwards of 20,000 addresses, all of which have been recently checked. As in previous volumes, the particulars given have been obtained from official sources, and have been verified at the latest possible date by responsible officers of the undertakings concerned. There are a number of maps in the book; and accompanying it is a large map showing the electric light, power, and traction undertakings in the United Kingdom. The volume (occupying with the index 1822 pages) has been compiled under the direction of Mr. Emile Garcke, and is published at Nos. 13 to 16, Fisher Street, W.C., at the price of 21s. net.

The Ammonium Finance Syndicate, Limited, of Victoria Street, Westminster, have sent us a copy of an illustrated booklet they have issued, descriptive of the Riversdale scheme for the utilization of a large coal property situated in the Vryheid District, Natal, which they have acquired, and which it is considered possesses unique advantages for the installation of Mond plant for the production of sulphate of ammonia and other bye-products. Samples of the coal contain 1·89 to 2·22 per cent. of nitrogen, compared with 1·2 to 1·4 per cent. in English coal.

SOCIÉTÉ TECHNIQUE DU GAZ EN FRANCE.

PAPERS AT THE ANNUAL CONGRESS AT TOULOUSE.

HEATING OF BAKERS' OVENS BY GAS.

By M. ROULAND.

The heating of bakers' ovens by gas is one of the most interesting developments of the gas industry. It has received special attention at the hands of the Paris Gas Company, by whom steps have been taken, from the outset, towards the solution of the problem, and active efforts made in bringing this application of gas under the notice of bakers. The results so far obtained make it possible to say there has been great progress of late years, which augurs well for the future of this application of gas.

A solution of the problem will provide a new and considerable field for the sale of gas. In Paris, the average consumption in a bakery using gas exclusively as fuel is about 12,000 cubic metres per annum (433,000 cubic feet); and there are in Paris some 2400 bakeries. In other words, a consumption of 30 million cubic metres (about 1060 million cubic feet) of gas would be ensured should this mode of heating become general. On the other hand, we have to take part in a species of reform movement. It is strange that the industry most necessary to our existence has preserved until now its old-time methods, while many others have improved their plant and processes with the object of reducing manual labour. The time thus appears ripe for the bakery business to share in the general improvement in conditions of work. Even now a mechanical kneading-trough, actuated by a dynamo or a gas-engine, has supplanted in many establishments the laborious preparation of the dough. Heating by gas will likewise avoid the manual handling of wood and the removal of the red-hot charcoal, with its attendant unpleasant effects in the bakery. Moreover, it will allow of bakings in more rapid succession, and possibly of doing away altogether with night work.

THE SOLID FUEL HEATING.

Before describing the different types of gas-burner which have been in use for some time past in the Paris bakeries, it may be well to describe briefly the customary baker's oven. It consists of a block of masonry containing an oven of great depth and small height, and, in plan, is of ovoidal shape, drawn out to a greater or less extent, with opening on the front of the block. In front of the opening is a cast-iron door, which moves vertically. By it the fuel and the bread to be baked are successively inserted. At the other end of the oven are two openings communicating with the flues by which the products of combustion escape up the chimney. The bed of the oven is flat, and slopes upwards from the door. The distance between the bed and the top varies between 28 and 40 centimetres (11 and 16 inches). In depth, the oven is as a rule 3½ metres (12 ft. 6 in.); its width, at the largest part, being about 3 metres (10 feet). For the regulation of the draught, the openings referred to are fitted with dampers, which are moved by means of horizontal rods running along the front of the oven above the door.

Wood is the fuel most generally used, though in some Paris bakeries coke is employed in suitable ovens. Direct heating is almost exclusively adopted. The wood is first burnt on the bed of the oven; and, when the temperature required is reached (about 350° C.), the charcoal is withdrawn, and the bed of the oven cleaned. A period ranging from three-quarters of an hour to an hour is allowed to elapse for the temperature to become even and for the bed of the oven to cool a little, after which the bread is put in. In more modern furnaces, using wood or more usually coke, there is either below or at the side of the oven a special hearth with a grating on which the fuel is placed. The burnt gases enter the oven, and pass through it to escape by the chimney. The oven being thus heated, the bread is put in as when heating directly on the oven bed.

It may be mentioned that the Comité Central des Cokes de France has studied the use of coke as a fuel for bakers' ovens, with the view of using it in place of coal in certain furnaces. Coke can be used in bakeries only with ovens specially built for this kind of heating; but, as will be seen from the data given below, heating by gas may be applied, without alteration of the masonry work at present using wood as fuel, to ovens which are in the majority.

GASEOUS HEATING.

Gas as a fuel for bakers' ovens was suggested as long ago as 1801 by Philippe Lebon; but no application was made prior to 1882, when experiments were undertaken. The fear was then expressed as to contact of the gas with the surface on which the bread lay. Also the furnaces were made with external heating. But it was found that baking by this method was far too costly at the price then charged for gas in Paris—*i.e.*, 30 c. per cubic metre (6s. 9d. per 1000 cubic feet).

The application of gas heating can only be undertaken with any prospect of success, at any rate at first, by means of appliances which can be used in existing ovens without altering them, and leave the baker free to return, if he so desires, to his former fuel. On these lines, the most simple method consists in inserting by the oven door (kept open) a burner which rests on the bed of the oven, and may be turned towards the floor or sides in order to adjust the heat, as when using wood. M. Méker, at the Congress of the Society in June, 1910, described an oven-heater which has been used in several Paris bakeries with very good results.* According to him, "with gas at about 16 c. per cubic metre [3s. 7½d. per 1000 cubic feet], the economy would compete with that of heating with wood." He added: "The solution of the question must remain with each gas company, who alone can know the consumption of the fuel and the minimum price at which it can be supplied. M. Méker invited companies to agree to charging special prices for gas for this particular use of it. In Paris, where the price of gas is fixed at 20 c. per metre (4s. 6d. per 1000 cubic feet), the reduction in the cost of baking requires to be sought in improving the efficiency of the heater; and to this end the Paris Gas Company has produced a burner which allows of the combustion of the gas in the oven by the quantity of air actually needed.

SOME MODERN GAS HEATERS.

A heater on these lines was the subject of a patent taken out on Jan. 30, 1911. As shown in fig. 1, it consists of a series of horizontal bunsen burners A and B, mounted on a pivoted pipe C D. Thus the burners can be introduced into the oven for heating (the door E, provided with its counterweight F, being raised), or, on the other hand, placed the length of the masonry during the putting-in of the dough and during the process of baking. Each

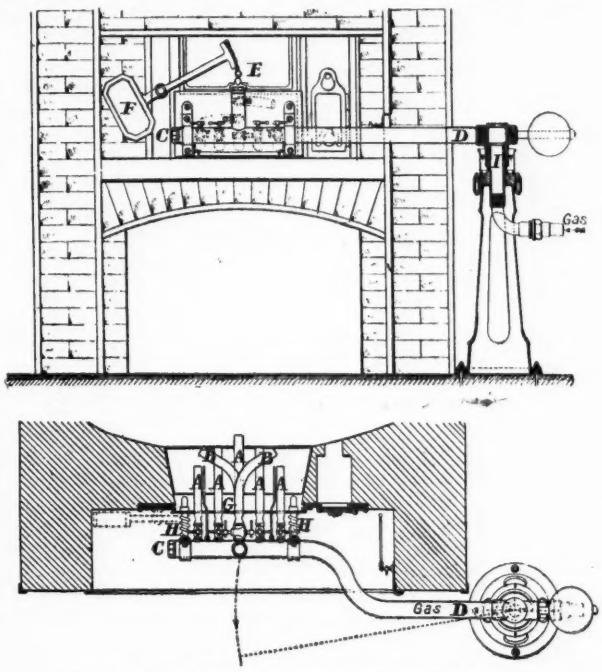


Fig. 1.—The Paris Gas Company's Bakers' Oven Heater.

of the burners is controlled by a cock, and the whole battery is provided with a plate G which acts as a shutter during heating—replacing the ordinary door of the oven. By the side of the burners, openings are made in the plate for the admission of air; these openings being regulated by a hinged valve or a damper. The shutter plate is fitted with two springs H, enabling it to act as a safety-valve in case of excessive pressure in the oven.

In using the appliance, the bye-pass burners fitted to it are lighted, the battery of burners moved on its pivot and introduced into the oven, the "*houras*" [the openings already referred to] being completely open. By means of the control taps, the burners are lighted, and the draught regulated partly by means of the openings and partly by the damper controlling the secondary air inlet. The apparatus does not contain any flexible tube—a special fitting ensuring gas-tight junctions between the pivoted pipe and the fixed supply-pipe I.

The bulk of the apparatus in the bakery may be reduced by constructing it with a double joint. Special care is taken to ensure the complete closing of the oven, allowing of the secondary air being reduced to the minimum. This is important as regards heating efficiency; on the other hand, this form of apparatus is placed as a fixture in the mouth of the oven, and the position of the flames cannot be varied during heating. In the case of heaters to be described later on, steps have been taken to give the baker the facility for directing the heat either towards the mouth, back, or either side of the oven. The door is then left open during heating, and the supply of secondary air in the oven controlled only by the openings.

The "Helcé" heater, shown in fig. 2, consists of a plate secured

* See "JOURNAL," Vol. CXI., p. 197.

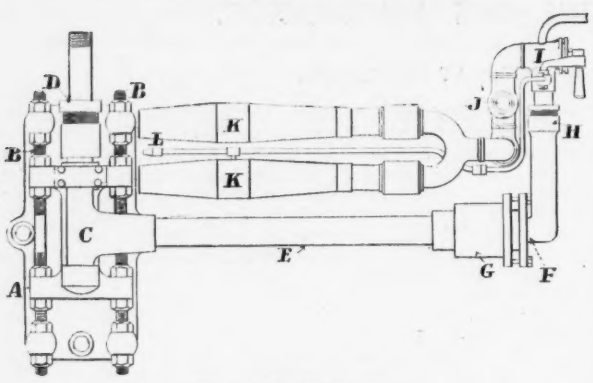


Fig. 2.—The Helcé Burner.

to the front of the oven. A carriage A can move up and down; its height being adjusted by its position on the two rods B. This carriage bears the rotating piece C, which is fitted with a racked joint D, into which enters the gas-inlet pipe. There are two telescopic tubes, E, F, each provided with packed joints, G, H. F carries the rotating joint of the burner. A cock I controls the supply of gas; and the joint J allows of the burner being inclined according to the slope of the oven. The burner itself, K, is fitted with six bunsens and two bye-pass burners L. The apparatus can move to and fro horizontally, and has three different rotating movements around J, C, and H. The flame can thus be directed into all parts of the oven.

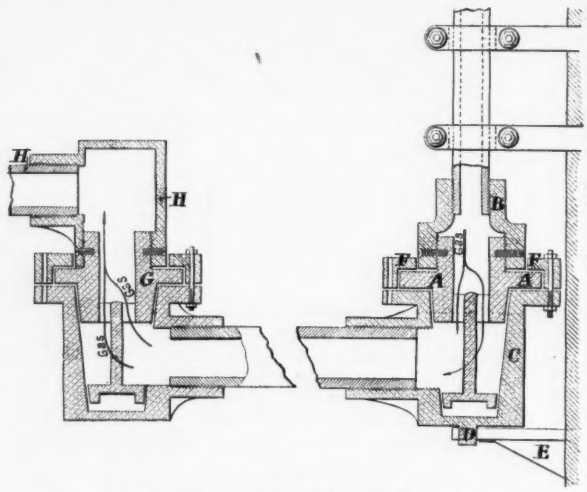


Fig. 3.—The Oudeville Gas-Supply Apparatus.

In the Oudeville apparatus, shown in fig. 3, there are two essential parts. The first is the double-jointed head through which the gas is delivered; one of the joints being placed on the gas-main, and the other near to the cock of the heater proper. The gas-supply pipe is of iron, and is fixed to the wall by two collars. It is connected to a conical member A by means of a joint B screwing into it. Set-screws hold the screw in place. A is ground, so that a female member C, resting by a pivot D on a bracket E fixed to the wall, can turn with slight friction round A. A gas tight junction between the male and female members is ensured by a collar F and a pair of nuts and bolts. All the joints are of bronze. A is split, so as to permit free passage of gas in all positions. The second joint is similar to the first; but in it G is pivoted. The joint H is at right angles. To it is screwed the pipe of the heater proper.

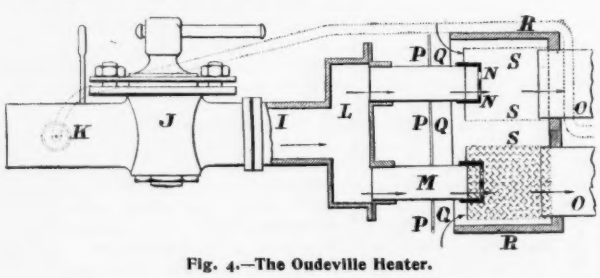


Fig. 4.—The Oudeville Heater.

In the second part of the heater, shown in fig. 4, the gas entering at I is controlled by the cock J, screwed on to the part H of the jointed head already described. This cock carries a second safety cock K for the supply of the bye-pass burner. The gas passes into the chamber L, and into the tubes M, the number of which varies. It then enters by the injectors N into the mixing-tubes O, carrying with it the air required for combustion. This latter, is adjusted by two screws which move a damper P to a greater or less distance from the plane of the cut-off Q. At the first point of each mixing-tube in the reservoir R is a cylinder S, through which air passes into the mixing-tubes. It prevents all chance of back-firing. A bye-pass, which remains constantly lighted, ignites the mixture of gas and air at the extremity of the mixing-tubes. The area of flame then extends along the oven. The burner is put out of action by closing the cock J, and next shutting off the cock K. By means of the jointed head, the flames may be readily turned to the right and left of the oven. Also, for ovens of great breadth, the tubes are modified, forming a species of movable fan, which allows of heating the most difficult part of the oven. If the draught is bad, the flame does not always reach the back of the oven. In this case it may be elongated by increasing the air by means of the two screws.

Before passing to special ovens and more recent apparatus, it should be stated that the Mécker, Helcé, and Oudeville burners are those which have been used for the comparative tests (detailed below) by the Paris Bakery Syndicate. They are in regular service in different bakeries. Apart, however, from the use of such burners in existing ovens, the question arises as to the design of ovens specially for gas heating, and affording as complete utilization as possible of the heat produced. At the Congress of the Society last year, M. Charles André described a sanitary oven invented by him, consisting of two chambers, one above the other, heated from the outside by gas. At the gas exhibition at Antwerp in March last, the Belgian branch of the Continental Gas-Meter Company showed an oven with outside heating for bakers and confectioners. This apparatus has been studied specially with the view of securing absolute uniformity in the temperature within the oven. The consumption of gas stated by the makers is 35 cubic metres (1235 cubic feet) for a daily make of 650 kilos. (1430 lbs.) of bread—say 5·4 cubic metres per 100 kilos. This figure would be lower than that which we obtained in the Paris bakeries when using the gas heaters described below.

The first type of apparatus patented by the Paris Gas Company has since undergone several modifications. The shutter plate at the mouth of the oven has been dispensed with, and a jointed head employed, by which the baker may direct the flames from right to left or *vice versâ*. In November last, a new apparatus was patented by the Company as a result of attempts to reduce the size of the heater. The object has been to bring the

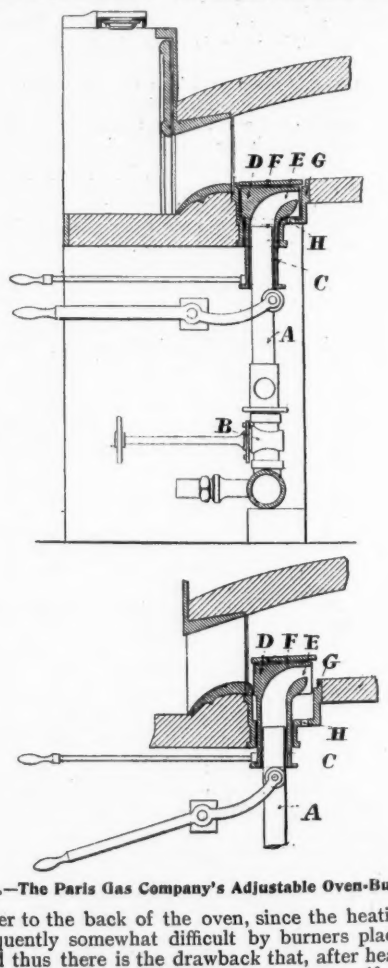


Fig. 5.—The Paris Gas Company's Adjustable Oven-Burner.

flames nearer to the back of the oven, since the heating of this part is frequently somewhat difficult by burners placed at the mouth; and thus there is the drawback that, after heating, time is lost in waiting for the temperature to become uniform before putting in the bread. This patented heater has not yet been constructed and tested. Fig. 5 shows the heater first lowered and secondly raised when heating the oven. The bunsen burners

A are controlled by cocks B. The number of burners varies, and they are of large section, and fixed direct on the pipe—no joints or flexible tubes being used. Each burner is capped by a cast-iron mantle C, which is prolonged by a cylindrical extension D, in which are horizontal holes E. The upper part of this extension being liable to wear away, a plate F is laid on it for renewal as may be necessary. The whole of the movable block can be raised by means of the lower lever, and can be caused to rotate round the burner by the upper lever. The block fits into a cast-iron frame G, which forms part of the masonry of the oven. When raised, the extension projects above the floor of the oven; when lowered, it is level with it. In heating the oven, the cocks B being closed, the door is opened, and the blocks D raised; the *houras* opened, and the bye-passes lighted. The cocks are then opened, and the burner lights. The secondary air is supplied through the aperture H. The heating of the oven is watched through the open door or through a temporary one having an aperture in it; the flames being directed to the right or left by the upper lever, in order to heat the sides. When shutting off the heat, the cocks B are closed, and the blocks returned to their frames.

Advantages of Gaseous Heating.

Reference must now be made to the measures taken in order to bring before the bakers in Paris the advantages of heating by gas. In March and April last year, the Paris Gas Company, in conjunction with the Chambre Syndicale de la Boulangerie, arranged a series of comparative trials, held under the patronage of the Minister of Agriculture, the Municipal Council, and the Society for the Encouragement of National Industry. As already stated, the heaters tested were those of the Gas Company, the Helcé, the Méker, and the Oudeville. The experiments were carried out on the following lines: First, for a week, wood was used as fuel; then in the same oven the different gas heaters were used, each for a week. Three bakings were made daily, each of the same quantity of bread—viz., 80 loaves, taking 1·2 kilos (2 6 lbs.) of dough. This was kneaded mechanically; care being taken to ensure uniformity. The flour and yeast throughout were of the same composition. In the whole series of tests, weighing and measuring were carried out so as to make the comparison as exact as possible. The following figures give the average results obtained in respect of the five different modes of heating:—

Heating by Wood.

Dry wood burnt	115·3 kilos. (= 136·65 kilos. green wood.)
Charcoal recovered	15·466 kilos.
Period of first heating	58 min.
,, ,, second and third heatings	21 ,,
Qualities of bread as denoted by experts' figures—	
Appearance and colour	18·3
Cleanliness	15·2
Baking	17·3

The total quantity of wood consumed (691·8 kilos.) was obtained from 819·91 kilos. of green wood. The cost was 45 fr. 2 c., less the return on the 92·8 kilos. of charcoal.

Heating by the Lequeux Burner.

Gas consumed	43·333 cubic metres.
Period of first heating	1 hr. 5 min.
,, ,, second and third heatings	26 ,,
Qualities of bread as denoted by experts' figures—	
Appearance and colour	17·1
Cleanliness	19·7
Baking	15·7

At 20 c. per cubic metre, the cost of the gas was 52 frs.

Heating by the Cayron Burner.

Gas consumed	48·166 cubic metres
Period of first heating	47 min.
,, ,, second and third heatings	17 ,,
Qualities of bread as denoted by experts' figures—	
Appearance and colour	19
Cleanliness	20
Baking	19

At 20 c. per cubic metre, the cost of the gas was 57 fr. 80 c.

Heating by the Méker Burner.

Gas consumed	44·333 cubic metres
Period of first heating	47 min.
,, ,, second and third heatings	20 ,,
Qualities of bread as denoted by experts' figures—	
Appearance and colour	15·7
Cleanliness	20
Baking	15·4

At 20 c. per cubic metre, the cost of the gas was 53 fr. 20 c.

Heating by the Oudeville Burner.

Gas consumed	46·166 cubic metres
Period of first heating	44 min.
,, ,, second and third heatings	20 ,,
Qualities of bread as denoted by experts' figures—	
Appearance and colour	18·5
Cleanliness	20·0
Baking	17·4

At 20 c. per cubic metre, the cost of the gas was 55 fr. 40 c.

In their report on the tests described above, the Chambre Syndicale de la Boulangerie acknowledge the evidence thus furnished as to the many advantages of gas heating as regards simplification of the work, convenience, and in respect to the baking of the bread—its cleanliness, appearance, and colour. The results, it is stated, have been perfect in every case. As regards cost, the Chambre Syndicale assume that tests on a larger number of ovens, and these better adapted for gas heating, would show a notable reduction; and improvements in the heaters in the future will likewise lead to reduced cost. In favour of gas, it is admitted that the wear and tear of the ovens is less, and that the sweeping of the chimneys is dispensed with, as is also manual labour, drying, chopping, and storage of the wood, &c.—all positive advantages which will surely be appreciated by bakers who adopt the new method, which the Chambre consider is destined to render great service to the baking trade in the future.

M. Virat, the President of the Syndicat Patronal de la Boulangerie, after admitting that bakers are adopting a more friendly attitude towards gas heating than they did to mechanical kneading on its introduction in 1908, observes that all the loaves in a single gas-heated oven have been shown to be equally baked, and free from the more or less dark colours produced in ovens heated by either wood or coke. In the matter of cleanliness, the bread baked by gas was accorded the highest figure of 20 by all the experts. The general opinion of the tests is thus favourable to gas; and since they were made, the number of bakers in Paris employing the new method has increased to a notable extent.

As regards cost, the results obtained in the tests and recorded in the figures already given were not satisfactory. Actually, the conditions were unfavourable to gas. The oven was larger, in both depth and height, than the majority of those in Paris; and the adoption of three bakings per day, which is much less than the number in regular work, was also unfavourable to gas heating. It cannot be said that the tests show the cost of gas heating in an ordinary bakery. The following table gives the consumption of gas in seven Paris bakeries:—

Type of Heater.	Consumption per Hour.	Number of Bakings per Day of 24 Hours.	Total Weight of Bread per Day.	Total Consumption per Day.	Gas Consumed per 100 Kilos of Bread.	Average Consumption of Gas for Each Baking.	Remarks.
	Cubic Metres		Kilos.	Cubic Metres	Cubic Metres.	Cubic Metres.	
Paris Gas Company's Patent	23	5	420	35·07	8·35	7·00	Oven heated only at night.
,, ,, ,, ,,	25	8	655	52·00	8 00	6·50	Three bakings in the day-time and five at night.
Cayron	30	11	950	89·20	9·40	8·10	Oven heated only at night.
,,	30	18	1478	112·50	7·60	6·25	Oven heated day and night.
Méker	23	9	840	58·48	7·00	6 50	Oven heated only at night.
Oudeville	28	5	350	38·00	10·85	7·60	Oven heated day and night.
Cayron	30	11	724	55·00	7·60	5 00	Oven heated only at night.

The ovens have the following average dimensions: Length, 3·8 metres; width, 2·5 metres; height, 35 centimetres. The average consumption of gas per 100 kilos. of bread is found to vary with the nature of the bread. Larger loaves should entail a smaller consumption than the same quantity of small or fancy bread; while the economy in the gaseous fuel also depends upon the skilful management of the apparatus.

Though no figures for the cost of wood were available in the case of the bakeries included in the foregoing table, it is judged that, with gas at 20c. per cubic metre, the cost is about the same as for wood, so long as no allowance is made for return on the sale of charcoal. This last item is not negligible; but it varies considerably. In some parts of Paris, it is somewhat difficult to dispose of charcoal.

In order to arrive at a just comparison of price, it is necessary to take into account the advantageous features of gaseous fuel already mentioned. If the gross cost of heating were the sole factor considered by bakers, it would not be easy to understand why so few have adopted the use of coke, which is considerably cheaper than wood. Actually, not one-third of the bakers in Paris employ coke. As regard those who use gas, they number at present in Paris about 40, representing 50 ovens, and a total consumption of gas, up to the present, of 500,000 cubic metres (about 17¾ million cubic feet). The daily consumption of some reaches 100 to 150 cubic metres (3530 to 5300 cubic feet). Those who have adopted gas declare themselves satisfied with it; and during the recent strike they were able to carry on their business with a smaller number of hands. In short, the Paris Gas Company are, so far, encouraged by the steps they have taken to pursue their plans of developing this application of gas heating. It may be hoped that their enterprise will prove of benefit to the gas industry as a whole.

DECOMPOSITION OF THE CARBON BISULPHIDE IN LIGHTING GAS BY HOT PURIFICATION.

The following is an abstract of the paper on the above subject read before the Société Technique by Mr. Charles Carpenter, Chairman of the South Metropolitan Gas Company. The communication was highly appreciated by the assembly.

After paying a tribute to the work of M. Guillet on the same subject (Congress of 1912), and of Professor Sabattier on catalysis, Mr. Carpenter reviewed the various attempts made since 1819 in the direction of hot purification and freeing the gas from carbon bisulphide. Although several years ago, on the proposition of Lord Rayleigh, compulsory elimination of sulphur compounds was removed by an Act of Parliament, the South Metropolitan Gas Company, realizing the great importance of their elimination from the point of view of the popularity of gas, continued their researches. Mr. Evans, the chief chemist, made a study of catalytic reactions, and an experimental installation in 1908 at the Bankside works indicated the possibility of arresting the carbon bisulphide by this method. Since that time the process has been improved in various ways, and an installation capable of treating 283,000 cubic metres (nearly 10 million cubic feet) of gas per 24 hours is working very satisfactorily at the Old Kent Road works.

The principle of the process is as follows: The gas is first heated up to 410° C. by passing through a large number of tubes nearly 2 inches in diameter, and 20 ft. 6 in. in length, themselves heated by producer gas burnt in the combustion chambers. It then passes into the retorts or tubes containing the catalyzing agent—balls impregnated with reduced nickel, maintained at a temperature of about 430°. The catalyzed gas next passes to a temperature changer, where it gives up part of its heat units to other gas arriving at the apparatus. Finally, it is taken to the coolers and ordinary purifiers. The reaction is shown by the equation:

$$CS_2 + 2H_2 = 2H_2S + C.$$

The freed carbon remains fixed on the catalyzer, whence it is removed by combustion after thirty days' working. The result of a long period of working is that the average sulphur content of the gas per 100 cubic metres has been reduced from 92·2 grammes to 17·8 grammes—a reduction of 80·7 per cent. There is necessarily some variation with different kinds of coal. The cost of the process, including heating, labour, and amortization, works out at 13·13 c. per 100 cubic metres (0·35d. per 1000 cubic feet), and will be brought still lower by some improvements which the author has in view.

M. Boutan and M. Guillet in turn paid tribute to the work of Mr. Carpenter, and the applause of the assembly showed what interest the paper had aroused in members present. M. Guillet remarked how audacious was this process. Sulphur being a born enemy of catalysis, it was remarkable that it had been made to enter into a catalytic reaction. But the fact that this method of purification had been applied on a large scale, and had given consistent results now for several years, added to its interest and importance.

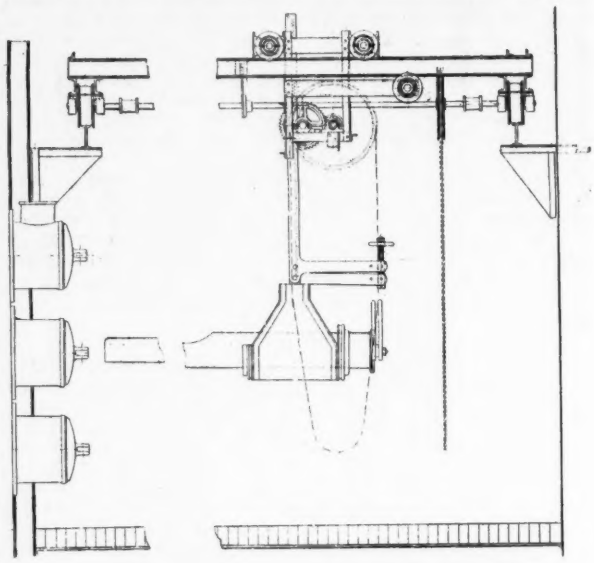
Replying to a question by M. Guillet, the author stated that the gas leaves the catalyzers at about 400° C., and leaves the temperature changers at 150°. In working out the costs, coke had been reckoned at 1 fr. 40 c. per 100 kilos. (6¾d. per cwt.)

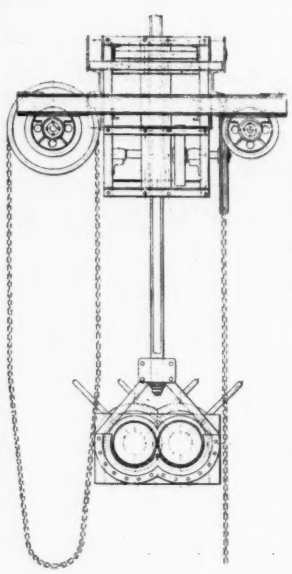
DOUBLE-SCOOP CHARGING MACHINE FOR SMALL WORKS.

By M. P. Bachelay.

[A Paper read before the Société Technique du Gaz en France.]

In the present state of the gas industry, it is becoming more and more necessary to obtain the highest possible yield of gas from the coal carbonized, with a minimum charge for heating and manual labour; and this is the case not only with large or medium-sized undertakings, but also in quite small works, which often have only one or two furnaces working in the summer months. One of the means to this end which has been adopted by larger works is mechanical retort-charging, which not only renders possible a certain saving in manual labour, but also introduces more regularity into the piling-up of the charge on the sole of the retort; at the same time enabling heavier charges to be used without detriment to the process of carbonization. But charging machines, such as the De Brouwer, the Sauters, the Zwilling, the Dunkel, &c., which are commonly used in these larger works, are of such a price as prohibits their adoption by smaller undertakings. However, in these latter, both in France and other countries, various more or less rudimentary systems of mechanical supports and elevators have found favour, but they have generally required of the labourer some considerable effort, and practically always, unless I am mistaken, the charge is only completed in two operations. I therefore thought it would be interesting to study the construction of a machine the price of which would be within the reach of small undertakings, and which, like its bigger brothers, would have the threefold advantages of simplicity, rapidity, and regularity of charge. It was on my instructions that the charging machine, which I shall have the honour of describing to you, was executed by the French Company "Lumière et Eau," and I hope that I shall have been of service to many of our colleagues in placing within their reach an apparatus low in cost, but simple and practical.





The apparatus is mounted on a sliding bridge, which moves mechanically on two rails in front of the settings. It is composed of a framework, carrying raising and lowering gear worked by a hand-wheel and chain fitted with a strong automatic brake, and working a strong rack, at the bottom of which is hung a vertical axle fitted with ball-bearings. This permits the double cradle on which the two scoops are fixed, side by side, to take up any position in the horizontal plane necessary to place the scoops parallel to the longitudinal axis of the retorts. A regulating screw, at the end of a branch at right angles to the frame, brings back the charged scoops to the horizontal position. The two scoops are made of steel plate, and are left open for the length of the retorts; the remaining part being kept cylindrical and suitably weighted, to counterbalance, in some measure, the weight of the coal. This cylindrical part rests in the cradle, and the ends of the scoops are fitted with levers, for tipping the coal—this being done from the centre outwards, half the coal to the right, half to the left. The operation is effected with the greatest ease, owing to the ball-bearings on which the scoops turn. All the rollers likewise turn on ball-bearings.

The scoops are filled, wheeled in front of the retort to be charged, and adjusted to the required height by the raising gear. Their introduction into, and withdrawing from, the retorts is effected by hand, but can also be arranged for mechanically if desired. The coal will be found to be spread absolutely evenly on the bottom of the retort, and has a groove down the middle which aids distillation and facilitates the insertion of the discharging implement. This machine is very easily worked by one man; it needs very little up-keep, no specialist being required for it, which is a great deal in the case of small works.

Value of Water Storage and Filtration.—Dr. A. C. Houston, the Director of Water Examination of the Metropolitan Water Board, has lately issued his ninth research report, and we have received a copy from the Clerk to the Board (Mr. A. B. Pilling). The author deals with the search for pathogenic microbes in raw river water and in crude sewage, and expresses the belief that storage and filtration would remove all likely danger from aggregated microbes, and also tend to render separated microbes fairly equally distributed throughout a water supply. He considers that the devitalization of typhoid bacilli under conditions of thorough storage, especially when followed by filtration, affords adequate protection to the consumers of London water, quite apart from the views enunciated in his report.

RESERVOIR STORAGE IN RELATION TO STREAM FLOW.

By William J. E. Binnie, B.A. (Cantab), F.G.S., M.Inst.C.E., and Herbert Lapworth, D.Sc., M.Inst.C.E., F.G.S.

[A Paper read before the Institution of Water Engineers, June 7.]

Existing Knowledge.

The question of the amount of reservoir storage required to equalize the fluctuations in the run-off from any drainage area is one that has not received the attention it deserves. This has been largely due to the fact that, in arriving at an estimate of the required storage capacity, gaugings of the actual stream to be impounded are seldom available, and engineers have generally had no alternative but to estimate—or guess—the run-off from the average rainfall as measured by rain-gauges. The authors have brought forward this paper in order to show the necessity of obtaining actual gaugings of the particular stream to be impounded before any really sound estimate of reservoir storage can be made.

The Hawksley Formula.—The first engineer who appears to have attempted a solution of the problem was the late Mr. Thomas Hawksley, who devised the following empirical formula:

$$N_s = \frac{1000}{\sqrt[3]{R_3}}$$

where N_s represents the number of days' storage and R_3 the mean annual rainfall of the three driest consecutive years. There is no doubt that, empirical though it may appear to be, this formula holds very well for many drainage areas, and has been of immense service to water-works engineers. The formula assumes that the entire average flow of the stream during the three driest consecutive years is to be abstracted. A little consideration will, however, show that, when only a portion of the average flow during that period is required, the number of days' storage of the required supply must be less than when the full yield for the three-dry-year period is utilized; for, to take an extreme case, if the amount to be abstracted for supply were only equal to the extreme dry-weather-flow of the stream, no storage would be required. The formula does not, therefore, help very much in those cases where it is intended only to abstract a portion of the mean flow during the three driest consecutive years; and it also takes no account of the losses due to evaporation, which we shall show must have considerable influence upon the amount of storage.

The Middleton Formula.—Another formula that has been devised by Mr. R. E. Middleton is—

$$N_s = \frac{500}{\sqrt[3]{r_3}}$$

In this case, r_3 is the average annual run-off during the three driest consecutive years. This formula takes the evaporation into account, and is therefore more rational than the older rule.

The Deacon Diagram.—The most important addition to our knowledge of this subject was published by the late Dr. G. F. Deacon in his article on "Water Supply" in the "Encyclopædia Britannica." It is to be regretted that this valuable contribution is so little known to water engineers. Probably it is because they would hardly be likely to refer to an encyclopædia for fresh light on this particular subject.

Dr. Deacon took the actual measured run-off from a particular drainage area during the year of most unfavourable distribution of flow, and plotted the figures so as to form a cumulative diagram, from which the necessary storage capacity of the reservoir was determined in the usual manner for any desired supply. This diagram was then extended so as to cover from two up to six consecutive dry years, on the assumption that the extremely unfavourable distribution of annual rainfall was repeated in each year—taking into account, however, that, whereas the mean rainfall of the driest year would be only 63 per cent. of the average rainfall, the mean of the two consecutive driest years would be 75 per cent. of the average, and therefore the second year in the series would have a rainfall of 87 per cent. of the average. The actual gaugings taken in the one dry year were therefore proportionately increased for the second year; and by a similar method a cumulative diagram extending over three, four, five, and six consecutive dry years was worked out. The results obtained in this manner are plotted on a diagram, which gives curves showing the yield of the reservoir in relation to its storage capacity for any mean annual rainfall between 30 and 100 inches, and also the number of consecutive dry years which that reservoir would equalize.

It is not clear from Dr. Deacon's article how the storage has been arrived at for drainage areas on which the mean annual rainfall differed from that contributing to the stream which was actually gauged; but the authors believe that the figures actually ascertained for this particular stream were increased or decreased in the same proportion as the annual rainfall. As far as the authors are aware, this was the first attempt to solve the problem so completely as to show the necessary storage for any proportion of the average run-off. The weakness in this diagram is, the authors believe, the assumption that results arrived at from the gauging of one particular stream could be made applicable to all cases. The assumption, also, that the annual distribution of rainfall would be similar in consecutive years and for wide variations of annual rainfall, can hardly be correct; and there is little doubt that the amount of storage obtained by using this diagram would be in excess of what is actually required in many cases.

Theoretical Considerations.

Actual gaugings of various streams show that they differ widely from one another, not only with reference to the yield per acre of drainage area (which will depend, of course, on the rainfall and evaporation), but also with regard to the extreme dry-weather flow. This extreme dry-weather flow bears no relation to the rainfall, and may be very much lower on streams having a high rainfall than on those with a low rainfall. Now, a little consideration will show that an essential factor in determining the necessary storage capacity of a reservoir is the extreme dry-weather flow.

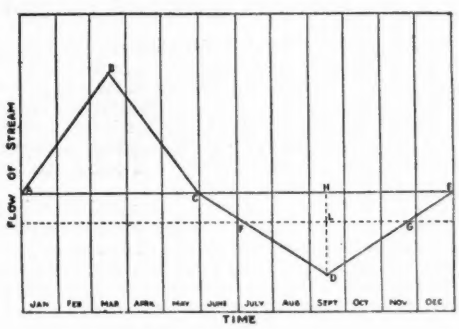


Fig. 1.

Assume that the average flow of any stream in any one year is represented by a horizontal line A E (fig. 1), and that the seasonal variations in the flow are such that they may be represented by two triangles A B C and C D E, one above and one below this line, on a diagram whose length represents one year, and on which variations in stream flow and water abstracted for supply are represented by vertical ordinates. Since A E is the average flow, the area of the triangle A B C is equal to that of the triangle C D E; the apex B of the triangle A B C representing the maximum flow, and the apex D of the triangle C D E representing the extreme dry-weather flow. Draw a horizontal line F G to represent the desired abstraction from the stream. Then the necessary storage to give the supply represented by the distance of the horizontal line F G from the triangle base would be represented by the triangle—

$$F\,D\,G = \frac{F\,G \times L\,D}{2} \qquad \ldots \qquad (1)$$

$$\text{and } F\,G = \frac{C\,E \times L\,D}{H\,D}$$

Substituting for F G in equation (1), the expression for the necessary storage becomes—

$$\frac{C\,E \times L\,D^2}{2\,H\,D}$$

L D represents the difference between the required yield and the extreme dry-weather flow, and $\frac{C\,E}{2\,H\,D}$ is a constant for this particular stream in this particular year.

The required reservoir storage should therefore vary as the square of the difference between the required yield and the extreme dry-weather flow. This we find to be approximately true in the examples given later.

Data used in Investigations.

The data used in the following investigations are shown in seven tables at the end of the paper. Two of these—namely, the Derwent Valley and Talla storages—may be open to criticism; hence the methods by which the tables are prepared are given in each case. The other tables were calculated from actual gaugings over the driest periods of the last thirty years. The authors are of the opinion, however, that the percentage of error where estimates were made cannot be large. Time has not allowed them to deal with other examples than those shown in the tables; but these represent the most important and accurate of the river-gaugings yet published in this country and the United States of America. They cover a range extending from a previous watershed, with a rainfall of less than 30 inches and a run-off of only 10 inches, to an impervious watershed with a rainfall of over 60 inches and a run-off of 55 inches. The result of the investigation shows that, so far as the data given are concerned, there is a definite relation between the storage required, the mean run-off, and the extreme dry-weather flow.

*The Derwent Valley.**—The records extend over a period o seven years, from 1906 to 1912 inclusive. Both the rain and river gauging were carried out with great accuracy. The average rainfall was estimated by comparing the rainfall of the seven years

* "Measurement of the Flow of the River Derwent, Derbyshire." By E. Sandeman, M.Inst.C.E., read at the Institution of Civil Engineers April 1, 1913. (Published in advance-proof.

with that of Redmires—an adjoining watershed in which rain-gauging has been carried on for a period of thirty years, and by proportion for the longer period. From this, a deduction of the average annual loss in the Derwent watershed gave the average annual run-off. In calculating the storages, a cumulative diagram was prepared for the two driest consecutive years (1887-8), of the last thirty years; the average distribution of stream-flow being taken as typical of each year. The total run-off was estimated as above by comparison with the Redmires rainfall records. The extreme dry-weather flow occurring in September, 1911, was adopted as the minimum.

*Redmires**.—The records given in the paper referred to extend over 29 years; both the rainfall and the run-off being measured. A table in the paper gives the monthly flows during the driest year of this period—namely, 1887—from which the table of storages was prepared for the smaller volumes, and in the larger storages by a method similar to that described for the Derwent Valley. The minimum dry-weather flow may be a little high. The rainfall records may not be accurate; for the authors understand that only one rain-gauge was used during the greater part of the period in question.

River Thames.†—In calculating the storages here, the actual gaugings during the years 1889 and 1890, when the river fell to its lowest, were used. The records published in the pamphlet extend over the nine years 1883-1891. The average rainfall was estimated by comparisons with Dr. H. R. Mill's records (1881-1911),‡ and the average run-off estimated by deducting the average annual loss. The minimum dry-weather flow was calculated from the least of the monthly flows in the period.

River Talla.§—The records in the paper extend over the seven-year period 1906 to 1912 inclusive. By comparison with Dr. H. R. Mill's records for Scotland (1881 to 1911), the average annual rainfall was estimated, and from this the average run-off. The storages were calculated by the same method as that used in the Derwent Valley for the two driest consecutive years 1887-8. The extreme dry-weather flow occurring in June, 1911, was adopted as the minimum; but it is probably high. The rainfall records are probably too low.

River Severn.¶—The records mentioned extend over the ten-year period 1880 to 1890. The storages were calculated from the actual gaugings in 1887 to 1888, when the run-off was at a minimum. The average rainfall was estimated by comparison with Dr. Mill's records (from 1881 to 1911), and the average run-off by deducting from this the average annual loss. The minimum dry-weather flow adopted occurred on July 31, 1885.

*River Sudbury, U.S.A.**—The records extend over the 23-year period 1875 to 1897. The necessary storages were calculated and published by Mr. FitzGerald in 1892;† and Table No. 6 is merely a transposition of his figures. The dry-weather flow is taken from another paper by the same author, read in 1886 before the American Society of Civil Engineers.

River Croton.‡—The records extend over the 32-year period 1868 to 1899. The storages were calculated from the gaugings of the three driest years 1880-1-2. The minimum dry-weather flow occurred in September, 1881, when the total monthly flow was 0·05 inch.

Analysis of Data.

The symbols used are:—

R = mean rainfall in inches per annum.
r = mean run-off in inches per annum.
d = minimum dry-weather flow in inches per annum.
n = number of inches per annum drawn for supply from the river.
s = inches of storage required to supply "n" inches per annum constantly from the river.

[For values of constants converting inches to gallons see Table VIII.]

It was obvious at the outset that, as no storage was required for an amount less than the dry-weather flow, the excess only of the supply above the dry-weather flow—*i.e.* $(n-d)$—was the correct factor to be considered in relation to the storage. It was found that, while there was a rough relationship between the rainfall, the storage, and the factor $(n-d)$, the last two factors and the run-off were clearly connected. After several trials, the various values of term $\frac{(n-d)}{r}$ were plotted to the corresponding value of s as base, as in fig. 2. From this it appeared that s was proportional to $\frac{(n-d)^2}{r}$. An inspection of the diagram, however showed that the figures for the streams with high run-off lay to the right, and those with low run-off to the left. In other words, some small correction for the value of r was required. Eventually, the term $\frac{(n-d)^2}{r^{1\cdot85}}$ appeared to give the best result. The values

* "Notes on the Sheffield Water Supply," by L. S. M. Marsh, "Min.Proc.Inst.C.E." Vol. CLXXXI., 1909-10.
† "The Flow of the Thames," by Sir A. R. Binnie, 1892.
‡ "British Rainfall," by Dr. H. R. Mill, 1911.
§ "The Yield of Various Catchment Areas in Scotland," by W. C. Read, Assoc.M.Inst.C.E., read at the Institution of Civil Engineers, April 1, 1913. (Published in advance-proof.)
¶ Private records in the possession of Sir Alex. Binnie, Son, and Deacon.

* Reports of the Boston Water Board and of the Metropolitan Water Board (Boston). Monthly data relating to the Sudbury, Cochituta, and Mystic.
† FitzGerald on "Rainfall, Flow of Streams, and Storage." "Trans. Am. Soc. C.E.," 1892.
‡ Report on New York's Water Supply, by John R. Freeman, 1900.

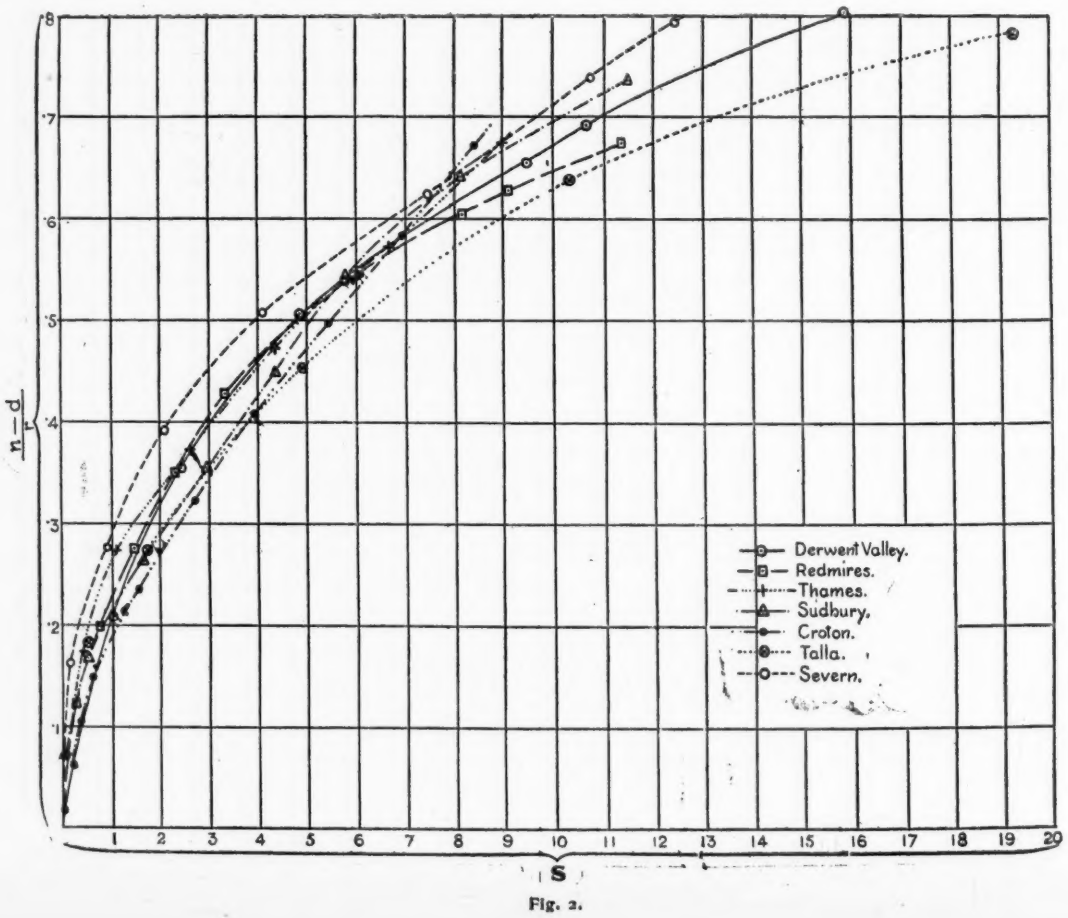


Fig. 2.

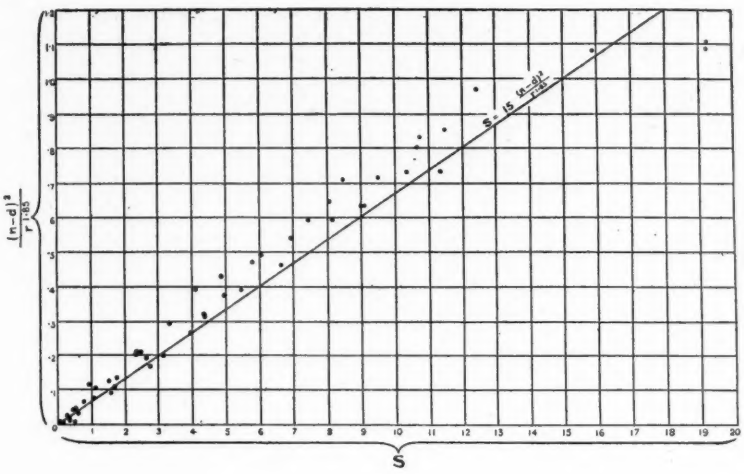


Fig. 3.

of this term are shown in Tables Nos. I. to VII., and are plotted in relation to s in fig. 3. From this diagram, the authors venture to suggest the formula—

$$s = 15\,\frac{(n-d)^2}{r^{1.85}} \quad . \quad . \quad . \quad . \quad (1)$$

as an approximate rule in determining the amount of storage for reservoirs, up to (say) three-quarters of the total yield. The line representing the formula is shown in fig. 3. The average value of the co-efficient is more nearly 13½ or 14; but the line touching the extreme values shown has been considered safer. Whether one is justified, with the present data, in adopting the refinement of a somewhat lower index to the value of r, is rather doubtful. For practical purposes the formula—

$$s = a\left(\frac{n-d}{r}\right)^2 \quad . \quad . \quad . \quad . \quad (2)$$

is simpler, and gives results identical with (1) with the following values of a.

	<..... Range of Data. .....>										
r	6·8	9·4	13	17	23	30	39	50	64	81	102
a	20	21	22	23	24	25	26	27	28	29	30

It should be added, however, that the formula is only put forward tentatively, as a temporary expedient of an empirical nature. Whether it will be applicable to all cases, and especially to those outside the limits of the observations, remains to be seen. But it seems fairly clear that there is a definite relation between the average run-off, the supply or draft, and the extreme dry-weather flow; and with further and more accurate research it is probable that the true laws connecting these factors will be ultimately determined. The supreme importance of the subject leads us to emphasize what has been so frequently urged—namely, the necessity of establishing in this country a Government Hydrological Survey.

Table No. I.

Derwent Valley.

Mean rainfall . . . . . R = 45·51 inches per annum.
Mean run-off . . . . . r = 33·67 ,, ,,
Minimum dry-weather flow . d = 3·00 ,, ,,

n Supply in Inches per Annum.	s Storage Required in Inches.	$\frac{(n-d)^2}{r^{1.85}}$
10	1·01	·073
15	2·45	·214
20	4·83	·429
25	9·50	·719
26·23	10·62	·801
30	15·86	1·08

Table No. II.

Redmires Watershed.

Mean rainfall . . . . . R = 40·42 inches per annum.
Mean run-off . . . . . r = 26·18 ,, ,,
Minimum dry-weather flow . d = 2·8 ,, ,,

n Supply in Inches per Annum.	s Storage Required in Inches.	$\frac{(n-d)^2}{r^{1.85}}$
6	·27	·024
8	·77	·064
10	1·47	·123
12	2·30	·201
14	3·34	·257
17·2	6·03	·491
18·6	8·15	·591
19·2	9·10	·637
20·4	11·35	·734

Table No. III.

River Thames.

Mean rainfall . . . . . R = 28·68 inches per annum.
Mean run-off . . . . . r = 10·00 ,, ,,
Minimum dry-weather flow . d = 2·28 ,, ,,

n Supply in Inches per Annum.	s Storage Required in Inches.	$\frac{(n-d)^2}{r^{1.85}}$
3	·08	·007
4	·42	·042
5	1·10	·104
6	2·62	·194
7	4·38	·314
8	6·65	·461
9	9·00	·635

Table No. IV.

River Talla.

Mean rainfall . . . . . R = 61 inches per annum.
Mean run-off. . . . . r = 55 ,, ,,
Minimum dry-weather flow . d = 5·0 ,, ,,

n Supply in Inches per Annum.	s Storage Required in Inches.	$\frac{(n-d^2)}{r^{1.85}}$
15	·50	·006
20	1·75	·135
30	4·92	·375
40	10·34	·733
48	19·27	1·107

Table No. V.

River Severn (Worcester).

Mean rainfall . . . . . R = 37·10 inches per annum.
Mean run-off. . . . . r = 17·33 ,, ,,
Minimum dry-weather flow . d = 3·20 ,, ,,

n Supply in Inches per Annum.	s Storage Required in Inches.	$\frac{(n-d)^2}{r^{1.85}}$
6	0·15	·040
8	0·92	·117
10	2·09	·235
12	4·09	·393
14	7·42	·593
16	10·75	·832
17	12·42	·968

Table No. VI.

River Sudbury (U.S.A.).

Mean rainfall . . . . . R = 45·77 inches per annum.
Mean run-off . . . . . r = 22·22 ,, ,,
Minimum dry-weather flow . d = 0·49 ,, ,,

n Supply in Inches per Annum.	s Storage Required in Inches.	$\frac{(n-d)^2}{r^{1.85}}$
2·1	0·018	·008
4·2	0·506	·044
6·3	1·64	·108
8·4	2·95	·201
10·5	4·36	·321
12·6	5·79	·471
14·7	8·05	·648
16·8	11·46	·854
18·9	19·22	1·088

TABLE No. VII.

CROTON RIVER (U.S.A.).

Mean rainfall . . . . . R = 48 inches per annum.
Mean run-off . . . . . r = 23 " "
Minimum dry-weather flow . d = 0·6 " "

n Supply in Inches per Annum.	s Storage Required in Inches.	$\frac{(n-d)^2}{r^{1.85}}$
1	0·033	·0005
2	0·21	·006
3	0·38	·017
4	0·60	·035
6	1·58	·088
8	2·75	·165
10	3·97	·265
12	5·43	·391
14	6·94	·540
16	8·43	·714

TABLE No. VIII.

MISCELLANEOUS CONSTANTS.

$$\text{Inches per annum} = \frac{\text{gallons per day per 1000 acres}}{61{,}940}$$

$$= \frac{\text{gallons per day per square mile}}{39{,}640}$$

$$= \text{Cusecs. per 1000 acres} \times 8{\cdot}69$$

Storage required in gallons = storage required in inches × area o gather ing ground in acres × 22,610.

ADDENDA.

As a matter of mathematical interest, the data show that the index of the term $(n - d)$ alters constantly with change in the term $(n - d)$ itself, and that the relation between the storage and the supply is logarithmic. The accumulation of more data, extending in each river over more than one dry period, will probably show that the expression—

$$S = e^{\frac{A\,(n-d)}{r} - \frac{B}{(n-d)}}$$

approaches a rational form, which should be applicable to extreme cases in which the average flow is very large or very small, and in which the whole of the flow is utilized. Or, in simpler form—

$$\log_{10} S = \frac{a\,(n-d)}{r} - \frac{b}{(n-d)}$$

The limited data show an equation of this type more closely fits the records than any other; b being equal to 1, and a having an average value of about 1·55. Or, to write a general expression—

$$\log_{10} S = 1{\cdot}55\,\frac{(n-d)}{r} - \frac{1}{(n-d)}$$

DISCUSSION.

Mr. C. P. HOGG (Glasgow) said the paper was of very great interest to all engineers engaged in the construction of storage works, and it would not be without interest to those corporations and authorities who had to pay for these storage works. The authors had entirely disarmed criticism by presenting their formula as a temporary expedient of an empirical nature. He would not venture to criticize the subject without much closer study of it than he had been able to give to it up to the present. As to the Hawksley formula, they had never regarded it with any great favour, as they did not think it was applicable to the conditions which obtained in his part of the kingdom. He thoroughly agreed with the authors that gauging of the particular stream to be impounded was of the greatest importance; and, having obtained the gaugings, he did not see why they should not follow them up by preparing a cumulative diagram—in fact, he should have expected them to lay greater stress than they had done on the cumulative diagram.

Mr. C. H. ROBERTS (Aberdeen) thought that water engineers were under an obligation to the authors for putting forward their formula, which was, he believed, the first one that took into account the minimum flow of a stream and the supply required. As the authors remarked, the factors of the minimum flow and the quantity required were of vital importance; for it appeared to him that without due consideration of these two factors it was impossible to correctly fix the size of a reservoir. It was no fault of the authors, but still it was rather unfortunate, as they themselves said, that they were not very confident as to the data upon which they based the formula. For instance, in the Redmires record, they said: "The minimum dry-weather flow may be a little high. The rainfall records may not be accurate; for the authors understand that only one rain-gauge was used during the greater part of the period in question." The same thought or remark seemed to run through all their comments on the records, with the exception of the United States records. He noticed that two of the records—those of the Thames and Severn—appeared to be taken from the lower flow of the rivers, while the others referred to the more upland streams. He would therefore like to ask the authors if they would state where the gaugings were taken for the Thames and Severn. He presumed those for the Thames were taken from the Thames Conservancy records. The result of not taking into account the minimum flow—more especially when it was high—and not taking into account the amount of water to be supplied, had no doubt been to design reservoirs larger than were really required. He did not think this was a very serious matter, because the population of the British Isles in the past had increased at a very rapid rate, and therefore the demand had soon overtaken the supply; but after the disclosures of the last Census, they were almost face to face with the fact that the population was ceasing to increase—certainly it was so in Scotland. It therefore behoved one to keep the fact in mind that reservoirs should not be constructed larger in size than was really required. He gathered the authors did not suggest that their formula would do away with complete gaugings; nor did he gather they suggested that the formula should take the place of Hawksley's cumulative diagram. In estimating for new works, it was not possible to obtain complete gaugings—there was not time. But in estimating the cost of new works, the minimum flow in the summer should be measured; and by inquiry in the neighbourhood among the residents, it was possible to gain some more or less accurate idea of the minimum flow of the particular stream being impounded, and to use the formula put forward by the authors. It would be necessary in some way to estimate the average flow from a particular drainage area. He was speaking more particularly with regard to making an estimate for the construction of a reservoir.

Professor A. H. JAMESON (London) said the authors had used a method common to all hydrographers. Formulæ were all empirical; but they must have some mental picture, and that was what the authors had supplied them with. By taking two triangles, they had shown the difference between the extreme dry-weather flow. Then they plotted their curve, and found they got very nearly the same result. As to the use of a formula, it was only for estimating purposes—it was never intended to replace the cumulative diagram, which took a number of years to prepare. In this formula, they had only to take the minimum of the dry-weather flow in a particular year, and then make an assumption of what the mean would be, and what proportion it would bear to the mean rainfall. The use of the formula was to clear their minds, and to render more accurate the estimate that they were making of the size of their reservoir. While the works were being constructed, he took it that a cumulative diagram would be prepared. The authors were not doubtful, but they wished to explain why they did not get one curve for the seven different watersheds. They had their curves nearly, but not quite, the same. Also, the constant might be altered.

Mr. C. H. PRIESTLEY (Cardiff) said he was not in a position to criticize any of the points mentioned. One fact they could deduce from the first part of the paper was that there were a great many drainage areas in this country which were practically being wasted, compared with others which were being utilized to their fullest extent. Generally speaking, in works of this kind, they did not find the best use was being made of the drainage areas. He presumed the authors were assuming that the best would in every case be made of the drainage area under consideration. From this point of view, it would be very desirable indeed if they had what had been mentioned time after time at their meetings—some central authority to see that the various drainage areas in the country were utilized to their fullest extent before small portions were roped-up for use and the rest practically wasted.

Mr. E. SANDEMAN (London) said he was one of the first to attempt to deal with the question of reservoir storage on scientific lines. The formula which had been referred to as the one made by Mr. Thomas Hawksley took no note of the dry-weather flow variation, which was a most important point. Many years ago, in dealing with a watershed which had a very high flow, he found it was quite useless to make a storage in accordance with this formula. In fact, with a dry-weather flow of 1¼ cubic feet per second for 1000 acres, he thought half the storage would be sufficient. That was to say, while the Hawksley formula needed 160 days' storage, possibly not more than 80 days' supply would be required in the case he had given. The reason was perfectly obvious—namely, that the dry-weather flow was a constant factor, and required no storage. If they had a watershed which yielded 50 million gallons per day regularly winter and summer, and that was the quantity required, they would need no storage; but if the yield was 49 millions in summer and 51 millions in winter, then they would require a very small storage. They would find that, as the dry-weather flow diminished, so the storage necessary would increase. The Hawksley formula was applicable only in cases where the whole flow of three dry years was to be taken; while the advantage of this new formula was that it was applicable to any proportion of the yield. From it, they could find the storage required for any given number of inches taken from the watersheds. The new formula was based upon results actually obtained from various watersheds during dry periods. The points to be raised were: With what accuracy were the results obtained? Secondly, did the results extend over a sufficient number of years? The first question he was unable to answer; and probably the authors could not answer it very well. But in regard to the second, he thought it was probable that, as the results extended over a greater number of years, it would be found the formula would require a little variation. Of course, the authors had put forward this formula, not as a final one, but in a tentative manner, until a larger number of gaugings and a greater number of years' records were available, when, he presumed, the formula would be revised. He suggested that they should err, if anything, upon the side of providing large storage by increasing their co-efficient to some extent. The reason for this was very simple. In designing a reservoir, the last foot put

on the top of a dam cost very little, but made a great difference to the storage. It was not worth while to cut down the last foot simply to effect a very small saving. He congratulated the authors upon having made a distinct advance in defining the relation between the storage requisite for the obstruction of a given proportion of the yield or of the run-off of the watershed, because up to the present time they had been really working somewhat in the dark, and this formula would be of great assistance in the future.

The PRESIDENT (Mr. C. Clemesha Smith, of Wakefield) congratulated the authors upon making an attempt to deal with the question of a scientific formula in relation to the storage of water. It would be useful if as many of their members as possible would put the formula to the test, and, if they could, either criticize or else confirm it in writing. A paper of this description lent itself better to a written than to a verbal discussion.

Dr. LAPWORTH then replied on the discussion. He said the question of the cumulative diagram not being dealt with in detail was a point they did consider; but it was so familiar to waterworks engineers that they took it for granted that it was the method used. Mr. Roberts had spoken about the accuracy of the data. They had given an honest criticism as far as they could of the data on which the formula had been based, because, after all, it was only fair, when there was anything new of this kind presented, that they should give the actual facts upon which their deductions were based. They had not criticized the United States record, because they thought it might be quite as inaccurate as the others. [Laughter.] They had to take the best they could; and the answer they gave as to the accuracy of the gauging was this: That considering the remarkable way in which all the curves lay within the narrow zone, it was extremely likely if the gauging were accurate, the width of that band might be much narrower still. There was very little doubt from the charts that there was a scientific law underlying this. The extraordinary thing was that the same law applied to the Thames—which was largely a chalk watershed, in which the water was stored up, and not given out to the streams for some months later. They had the same law in connection with an impervious watershed, from which the water ran off at once. When they started, they had no idea that they would get such similar results from rivers differing so much. The Severn gaugings were measured at Worcester; while the Thames records were those of the Thames Conservancy. A formula could not be obtained without gauging. The cumulative diagram could only come into use when they had got the gaugings for the dry period; but it seemed to him that a formula should give them approximate results if only they had two years' records to work upon. German hydrographers had told him that two years' gaugings should enable them to form a good idea. Without any cumulative diagram, it gave them a close idea of the amount of reservoir storage required. The formula really dispensed with the cumulative diagram, because it took the minimum and average flow. They had taken no notice of the three driest consecutive years, though this had been a rigid rule which had worked exceedingly well in the early history of waterworks engineering. In the early years, reservoirs were made too small; and as time went on, they had to be enlarged until they became of proper dimensions. This was found, roughly, to be about the three driest years' flow; but it was not a rule that should be applied everywhere, though it certainly did to many places, particularly in the North of England. Americans took no notice of it, and some worked on one rule and some on another; but the general plan in America was to tide over the driest year. The advantage of the formula was seen when they only wanted to use a small portion of the flow. Cases happened where they had a large watershed, and were going to construct several reservoirs one after the other; and the formula might be of some use here. As to the modification of the formula from time to time, this was inevitable. There was nothing permanent anywhere. In conclusion, he would like to say that they would be exceedingly interested if there was a written correspondence on the paper, showing whether the formula could be applied in all cases. They doubted very much whether it could, particularly in small watersheds. All the examples given were in connection with large watersheds. He would like it to be understood that what was referred to as the "Hawksley formula" was attributed to Mr. Thomas Hawksley, and not that it was definitely his.

A New Retort Cement.

The Lincoln Mineral Company, Limited, of Wandsworth, have recently introduced a new retort cement which appears to have exceptional qualities. We understand that the Company recently discovered a special silica, which is dug from an English pit in the form of a very fine powder, and is essentially different from the ground silicas and canisters which are in general use in this country. The cement works very "long," and has specially adhesive properties which render it unnecessary to use large quantities of adhesive material that are liable to affect its refractory nature. The cement swells slightly in the retort, thereby fitting itself closely to the hole under repair. We are informed that several of the leading gas companies have recently given orders for the cement; and engineers who have been regularly using it for six months appear to be well satisfied with it, and have expressed themselves to this effect. "Linco" is the name which has been registered by the Company in respect of this cement.

A GAS PRODUCER OF LARGE CAPACITY.

This is an abstract of the paper that was read by M. Marconnet on this subject before the Société Technique du Gaz en France last week.

Most of the improvements in gas producers introduced in recent times have aimed at getting rid of tar, and preventing the formation of clinker, or at any rate ensuring its easy removal. Favour has also been shown to slow working methods and the use of coal of high ash content, such as the anthracites. But unfortunately these particular coals are rare and of very high price. The actual speed of gasification varies between 50 and 100 kilos. [1 and 2 cwt.] of fuel per hour per square metre [10·7 sq. ft.] of section. Under these conditions, if it is desired to produce on a large scale, as, for instance, to supply modern motors of 4500 to 6000 H.P., impossible dimensions are arrived at. To avoid all difficulties of this kind, M. Marconnet proposes an entirely new type of producer of high gasifying power, having a unit power of 1000 to 5000 H.P.

The first attempt of the author to solve the problem was by using pulverulent fuels, obtained by preliminary crushing, and introduced into the producer by a current of air just sufficient to produce CO. The results obtained were as follows: Rate of combustion, 300 to 400 kilos. [6 to 8 cwt.] per hour per square metre of section; clinkering easy, in the form of a slag which can be rendered fusible by the addition of a flux and tapped as in metallurgy; finally, the possibility of using very fine coals, having ash-contents up to 50 or 60 per cent. The disadvantage of this method is the necessity of having some process for crushing the coal, and the author was led to study another system somewhat resembling that of the blast furnace. The latter, indeed, receives charges which do not contain more than 25 to 30 per cent. of carbon; therefore they work with a fuel containing 70 to 75 per cent. of ash, readily give up their clinker in the form of slag, and work at a great rate—often up to 3 tons per square metre tuyere section per hour. The chief difficulty of applying this principle to gas producers arises out of the difference in density of the charge. That of the producer being much less—0·8 as against 2·5—does not descend towards the air-injection tuyeres; it is the air which rises towards the charge, and the latter often sticks on the way. The author therefore devised a kind of heavy pick, which is to descend at intervals into the charge. It is intended to disturb the mass of fuel and so dislodge any which has stuck. The results thus obtained were interesting. Over a ton of breeze or very fine coke per hour per square metre of tuyere section could be gasified; with coke dust, which forms a less permeable mass, 700 kilos. have been gasified. If a little limestone-flux is added, the slag can be made to flow continuously. The temperature at the outlet varies between 300° and 425° C., and the CO_2 content never exceeds 5 per cent. To avoid corrosion of refractory parts by slag, some of the tuyeres at the top of the fuel are replaced by a cold-water circulator, such as that used in the water-jackets in metallurgy of copper. This water, during the first two or three hours' working, takes away 8 to 10 per cent. of the heat units, but later the loss is reduced to 3 or 5 per cent. This producer, which is not excessive in size, only needs for the blower and the poker some half per cent. of the power it generates, and is capable of dealing with the large amount of even poor fuel already stated.

M. Marconnet has been struck by the difficulty experienced in procuring good results from different kinds of coal with mechanical chargers installed under steam producers. He proposes now to heat them with producer gas from such producers as those described above, for which all kinds of coal can be used. It is easy, if the producer is near the boiler, to pass hot gases into the combustion chamber and to supply secondary air heated by passing through the walls of the chamber. Under these conditions complete combustion is effected with a very small excess of air—5 to 10 per cent. at the most; and the steam production of boiler can be increased as much as 30 per cent.

Commenting on the paper, M. Pierson pronounced himself more optimistic than the author on the subject of coal. Good fuel is not really so rare, and for more than twenty years he has always been able to procure his coal at a reasonable price. For instance, an eleven months' trial had shown that 2·8 centimes was the cost of coal per kilowatt-hour to an electricity generating station using his producers for gas of poor quality. M. Pierson does not at present consider it to be of any use aiming at producers for 4000 to 6000 H.P. motors, which use blast-furnace or coke-oven gas. He remembered that, in 1910, M. Godinet stated that the prices of poor quality coal and coke for producers should be in the proportion of 1 to 0·839; that if, for example, the coal is at 30 fr., coke should be at 25 fr. But the actual prices now at Paris are 33 fr. 40 c. and 33 fr. The speaker also recalled that, in 1912, M. Lhomme, with coke at 34 fr. a ton, had obtained the kilowatt-hour at a little over 2 centimes.

M. Rolland remarked that interesting points in M. Marconnet's producers were being able to supply large numbers of motors from a small number of producers, and to use poor quality coal. Replying to M. Bouvier, he said that coke dust had been tried, and that, when the gas is sent to the motors, it can easily be washed free of any dust or ashes that go with it.

WOODALL-DUCKHAM RETORTS AT DERBY (CONN.).

At the last Meeting of the New England Association of Gas Engineers, a paper was read by Mr. CHARLES H. NETTLETON, President of the New Haven (Conn.) Gas Company, giving the results obtained with the vertical retorts in operation at the gas-works at Derby (Conn.). The following are the principal portions of the communication, with some of the remarks to which it gave rise.

During the past year a retort-house has been constructed, containing a stack of four benches of four vertical retorts each, by the Isbell-Porter Company, under the Woodall-Duckham patents. Each retort is 24 ft. 8 in. long, 30 in. by 20 in. at the bottom, and 24 in. by 9 in. at the top. The whole stack is supported by heavy ironwork, and the bottom is 13 feet above the lower floor of the building, which is on the ground level. The size of the retort-house is 66 feet long by 34 feet wide, and 68 ft. 8 in. high to the peak of the roof.

The retort-house was started on Aug. 20, 1912, and has been in operation since. Throughout the autumn, three out of the four benches only were running, for the reason that, in heating-up one of the benches, the fire-clay material shrank so much that the sectional retorts drew apart—the upper section being held up by the covering over that particular bench. The bench was in consequence partly rebuilt, and has only lately been put in operation. For the three benches, the average yield was 75,000 to 80,000 cubic feet per bench. This was a great disappointment both to the constructors and to the managers of the gas company, as it had been expected that 120,000 cubic feet per bench would be produced. Since the fourth bench has been started, a record has been kept of the coal carbonized in it; and it has produced upwards of 100,000 cubic feet—on some days more than 120,000 cubic feet, assuming that the yield per pound of coal from the bench was the same as that produced from all the coal carbonized. The way in which the quantity of coal was determined may be of interest. The coke from this particular bench was weighed separately from the other coke; and from this the quantity of coal carbonized in the bench was readily determined.

The gas, after leaving the retort-house, is first passed through primary condensers, an exhauster, a Pelouze and Audouin extractor, secondary condensers, tar extractor, and a "Standard" washer, and then through a meter. All the apparatus, except the meter, has a capacity of 750,000 cubic feet, and the gas actually made was about 225,000 cubic feet. The readings of the meter were corrected for temperature and pressure; and allowance was made for the sulphuretted hydrogen contained, which was removed later in the purifiers.

To determine the actual results obtained from this retort-house, a test extending over eight days was made by Dr. A. P. Beardsley and Mr. E. C. Dunham, of the New Haven Gas Company, and Mr. W. O. Brewer, of the Meriden (Conn.) Gas Company. Tests were made in the daytime only. Covering the whole operation, the results were: Yield, 5·42 cubic feet of gas per pound of coal; candle power, 15·57 (the gas being tested with a Sugg "D" burner, with a chimney 6 inches high and 1⅛ inches internal diameter—the standard used being a pentane lamp, which had been tested by the Bureau of Standards at Washington); candle-feet, 84·4; calorific power, by a Junkers instrument, 615; do. by analysis, 645; heating feet (obtained by multiplying the calorific power by the yield), 3334. The average of all the analyses gave:

Product.	Per Cent.	Product.	Per Cent.
Benzol	0·55	Carbonic oxide	6·90
Carbonic acid	1·49	Hydrogen	45·02
Illuminants	3·98	Methane	37·33
Oxygen	0·28	Nitrogen	4·44

At a point about 7 feet higher than the top of the retort was set a water-gauge, and also a recording gauge to indicate the pressure upon the foul main. This was run as nearly as possible at a level gauge, or between that and 1-10th pressure. Allowing for the difference in elevation between this point and the mouthpieces at the bottom of the retort, where pet-cocks were inserted and a water-gauge was connected by means of a rubber tube, and also allowing for the temperature of the gas in the retort, it would be possible to have, if there were no stoppage in the retort or bridge-pipe, a vacuum of 5-10ths of an inch at the bottom of the retorts. On two occasions this vacuum was found. A summary of the pressure conditions at the bottom of the retort is as follows: The greatest pressure found was 5·70 inches; the percentage of total observations showing a vacuum, 33·6; the average vacuum, 0·19 inch. The percentage of all the observations showing zero was 5·9; that of all the observations showing pressure, 60·5. The average pressure was 0·89 inch.

Dr. Beardsley offered the suggestion that, if the coke-hopper at the bottom of the retorts could be connected, less gas would be lost from the retorts under pressure, and less combustion gas drawn into the retorts under vacuum. During the test, there was produced: Ammoniacal liquor, 5212 gallons, containing, by analysis, 1003 lbs. of ammonia, or a production of 5·88 lbs. per gross ton of coal; tar, 2163 gallons, or 12·66 gallons per ton of coal; pitch, 160 gallons, or 0·95 gallon per ton of coal. Referring to these in the order named, the Company are selling their ammonia as produced with a strength between 9 oz. and 11 oz., and are being paid for more than 5·1 lbs. per ton of coal. Dr. Beardsley says, in regard to the tar and pitch:

The most noticeable points about the tar are: About 5·3 per cent. of free carbon; a high percentage of tar acids; so little naphthalene that the portion of the distillate which contains most of it is liquid at ordinary room temperature. Also the fraction of the distillate boiling from 310° to 330° C. shows (by the dimethyl sulphate test) paraffin hydrocarbons amounting to 7 or 8 per cent. A horizontal retort tar will commonly not show any such hydrocarbons. All these facts indicate that the tar has not been subjected to high heat, and would seem to show that the bulk of it, at least, has either distilled off from, or has come up through, the comparatively cool core of the coal. The pitch, which is hoed out from the hydraulic main, is quite a different matter. It is very thick and heavy, and when cold will break or chip like ordinary coal-tar pitch. It is not homogeneous, but seems to consist of semi-solid material mixed with heavy tar. When warmed, a good deal of tar can be drained off. The residue when cold is very brittle. On the application of sufficient heat, it fuses with foaming. It appeared possible that the residue might be largely coal dust carried over from the retort. Therefore some of it was burnt to an ash, and was found to contain 0·72 per cent. of ash. This would indicate the presence of 9·6 per cent. of coal in the residue. The pitch as drawn from the main was mixed as well as possible by heating and stirring, and a determination made of the free carbon showed the amount was 27·19 per cent. It would seem, therefore, that this pitch is partly composed of coal dust, but is mainly the result of subjecting the tar vapours to destructive heat. It is suggested that it may have been formed from the portion of the tar which does not find its way into the comparatively cold centre of the retort, but passes through the hot coke or along the walls.

The analysis of the coal was:

	Per Cent.
Moisture	1·44
Volatile combustible	34·60
Fixed carbon	56·41
Ash	7·55
	100·00
Sulphur	0·94

To obtain the sample of coal, each day four shovelfuls were taken from each bunker, and at the end of the test the accumulated samples were crushed to pass a ⅛-inch screen and quartered down to the laboratory sample. The analysis of the coke was:

	Per Cent.
Moisture	—
Volatile combustible	2·40
Fixed carbon	84·76
Ash	12·84
	100·00
Sulphur	0·74

To obtain this sample, a shovelful was taken daily from each retort as it was discharged. The accumulated sample was then crushed and screened as in the case of the coal. For the eight days covering the test, the coke produced amounted to 68·57 per cent. of the coal charged. This is a large figure. The cause of it may be the following: A part of the tar produced in the retort condenses on the coal, and is redistilled, leaving as a residue a considerable proportion as coke.

A very peculiar thing connected with the operation of these benches is this: The coke drops from the mouthpiece black (that is, not incandescent). The writer has never yet seen any coke on fire coming from the retorts, yet it is so hot that it cannot be held comfortably in the hand. It is grey or black. He has been told that two or three times some coke on fire dropped out, and a little water had to be used; but it has been so infrequent that the statement can fairly be made that it comes out practically at all times black. This leaves the coke perfectly dry; but there is a slight disadvantage in this respect, that, when dropping the coke from the retorts, a good deal of dust arises, and also when it is dropped on the pile in the yard. A considerable quantity was forked-over to separate the large coke, and the residue passed over a ⅝-inch screen to divide it into fine coke and dust. The following percentages were obtained:—

Sizes.	By Weight. Per Cent.	By Measure. Per Cent.	Weight per Bushel.
Large coke	90·96	93·70	29·86 lbs.
Fine coke	3·74	3·06	37·64 ,,
Dust	5·30	3·24	50·26 ,,
	100·00	100·00	

For the eight days the quantity of coke used to heat the retorts was 26·04 per cent. of the coke produced, or 17·86 lbs. of coke to carbonize 100 lbs. of coal. It was believed this disappointing showing came from two causes. The producers were made larger than was necessary, and the retorts were so thoroughly protected by tile (following a plan that had been used in Europe successfully) that it took more coke than it should have done to produce

the heat desired inside the retorts. On the bench that was rebuilt, a good deal of this protecting material around the retorts was removed, and the producers were made somewhat smaller, with the result, as stated before, that the yield of the bench has been materially increased, and the consumption of coke reduced from 26 to about 20 per cent., or from 17·86 lbs. to about 13·6 lbs. of coke to carbonize 100 lbs. of coal.

Under the producers are rocking grates. These remove the larger part of the ashes, and the fires are clinkered only once in 48 hours. For three months no supplemental bars have been driven, except on one occasion; and the clinkering consists of using a poker and pushing it back over the grates and stirring up the fire. The ashes drop into shoots with self-sealing lids, and from these are drawn out once a day into barrows. The ashes are very fine and very dry, as no water is used, and, when drawn under present conditions, produce a large quantity of dust. The temperatures were taken by a Wanner pyrometer; and in this connection Dr. Beardsley reports as follows:

At the top of the combustion chamber, each bench at the front is fitted with four ports through which the heats may be observed; and also with four ports at the back of the stack, 5 ft. 3 in. above the bottom of the retorts. Four times daily readings were taken at each of the top ports—the hottest points in the bench. The average temperature for eight days was 2228° Fahr. Though fairly constant conditions were the rule, the heats were subject to considerable variation. They are not the same at the four ports of a single bench, particularly in the end benches. Individual heats can rise 300° in three hours; and the average heat of all three benches once rose 120° in a little over two hours. Attention is necessary to prevent the rapid development of local excessive heat. This is perhaps due to the large capacity of the producers, which permits a rapid increase in the amount of producer gas made. The lowest heat recorded was 1901° Fahr.; the highest, 2507° Fahr.

Occasional sets of readings were also taken at the bottom of the combustion chamber, and at the stack just above the dampers; and the results were as follows: Average temperature at bottom of combustion chamber, in back, 2067° Fahr.; average at stack, 1110° Fahr.

Recently tests have been made as to the power required to operate the coke extractors and the shaking grates, and, as nearly as can be determined, it amounts to 0·6 H.P.

On the outlet flue from one of the benches an upright tubular boiler, 3 feet diameter and 8 feet high, has been introduced, all the waste heat from one bench passing through it. The steam from the boiler runs a duplex Worthington pump, pumping weak ammoniacal liquor to the far end of the foul main. The exhaust steam from this pump, supplemented by a little additional steam from the works boiler, goes under the grate-bars so as to prevent the formation of clinker.

The pitch is cleaned out of the foul main and bridge-pipes twice in 24 hours, and generally is the most unpleasant and trying work the men have to do. Sometimes the pitch is very difficult to remove. While they do not meet with gas in cleaning the main, owing to a partition dipping below the level of the water, in cleaning the bridge-pipes, the gas comes out in considerable quantity, making the work much harder than it otherwise would be.

As to the labour, it is hard to judge, from a house the size of that in Derby, what it would be in larger plant. So far, we have had three men and a foreman on each shift; and apparently there was very little difference whether three or four benches were run. Two men look after the coke, fill the producers, clinker the fires, and clean the pitch out of the main and bridge pipes; the third man is on the top of the retorts supplying the coal to the magazines regularly, and running a bar down into the retorts frequently to prevent "bridging" of the coal.

With four benches making 100,000 cubic feet each in 24 hours, the make per man would be 50,000 cubic feet. It has seemed to the writer that the same men could look after a fifth, perhaps a sixth, bench, in which case the make per man would be increased to 62,500, or possibly to 75,000, cubic feet. The labour stated above does not bring in the coal; but it does take the coke, also the ashes, into the yard.

It is perhaps fair to add that, since the test stopped, the results in yield and candle power have not been so good; but for the month of January last the average yield was 5·31 cubic feet per pound of coal, the candle power was 15·63, and the candle-feet 83. We do at times obtain very much better results, frequently approaching 90 candle-feet, and have a few times exceeded this. Whether some careful operator will show a way by which the candle-feet can be kept above this point all the time, I do not know; but it does not seem an impossibility.

Speaking broadly, the vertical retorts at Derby may be said to be a success. I say this without any reference to myself, as others are very largely responsible for whatever results have been attained. The main features to my mind are admirable, in that so much of the work is done by simple, inexpensive machinery, not liable to get out of order frequently, and not needing expensive repairs; and also that so much of the work is done by gravity. On the other hand, various details have not been worked out satisfactorily; as, for instance, the quality of the fire-clay used in both retorts and settings, and the form of the setting itself. The fire-clay material used at Derby unfortunately shrunk not less than 3 inches in the length of each retort. I firmly believe, however, these difficulties will be overcome; and it is only fair to say that apparently they have already been overcome in England.

Given a retort-house where the daily make is 500,000 cubic feet or more, and after the details of the construction of the benches have been successfully worked out, the writer is inclined to think that more gas of an average quality can be made, with a given outlay for labour and repairs to machinery, than by any other method with which he is familiar. Whether the high candle-feet results produced by some of our friends with horizontal retorts can be reached is a question yet to be determined.

[The author subsequently added to his statement the following candle-feet figures: For October, 1912, 81·01; November, 78·79; December, 85·7; January, 83.]

At the close of the paper,

The PRESIDENT (Mr. Dana D. Barnum, of Worcester, Mass.) said the Association were fortunate in having Mr. Duckham with them; and he would call upon him to make a few remarks.

Mr. DUCKHAM thanked the President for his invitation. He said that he had visited Derby, and greatly appreciated the way the setting was built and the results obtained. The construction had features which he considered were superior to the English practice. Referring to the paper, he said there were one or two points which he should like to raise. He thought the variations in the speeds of the extractor gears were excessive. In regular working, a larger variation than 2½ per cent. would not be noticed, except when the gear was altered purposely. In England they worked at a speed of about one revolution in 58 minutes. He noted that they had had trouble with the fire-brick, as had also been the case in England. Had they been able to obtain suitable fire-clay from the start, they would have been in their present position several years earlier. The yield per bench was low—undoubtedly due to the excessive shielding of the retorts and the low conductivity of the material. In England, the through-put of the retort varied from 18 tons per setting of four retorts per 24 hours with Durham coal, to 20 tons of Yorkshire, 22 tons of Derbyshire, and 24 tons of Scotch. The question of fire-brick material was a most important one for all coal gas makers. In England they had dealt with the problem, and had greatly improved the quality of the bricks produced; and he was sure that a committee of gas engineers and fire-clay makers could raise the quality of the material in America. The candle power seemed somewhat low at Derby, when the composition of the gas and high calorific value were taken into account; and he would suggest that the various types of high and low "D" and "F" burners should be tried to get a more efficient effect. The quality of the gas was wonderful. In England, they did not make gas of such composition from "straight" coal. The methane figure was high and most valuable. The bottom pressure results were interesting; and the variation was due to somewhat uneven working. On the large retorts used in England, they never had any pressure; in fact, under all practical conditions, the pressure was about 1-10th less at the bottom than at the top of the retort. The presence of paraffin hydrocarbons in the tar showed that the gases leaving the retort had not been subjected to a sufficient amount of heat. They had now a sliding plate in the retort by which they could regulate exactly the amount of free space the gases had to pass in leaving. The author had mentioned pitch troubles; but he (Mr. Duckham) thought all vertical retort constructions had wallowed in pitch at one time or another. He was glad to say they had eliminated this trouble in England; and he was sure they would do the same in America. The percentage of volatile matter in the coke seemed high, as did also the quantity of coke used for fuel. In England, from tests made by outside engineers they had obtained figures of 11 to 11½ per cent.; and they hoped to get still lower. This figure was not through deduction, but was actual coke weighed—no allowance being made for ashes and moisture and steamed coke. He was surprised at the uneven temperatures given in the paper. They had no trouble in England in keeping these quite constant. Labour on all systems had been greatly reduced; but 150,000 cubic feet per man, working eight-hour shifts was a figure, for a 5-million cubic feet plant, as low as was obtainable with ordinary producers. He heartily congratulated Mr. Nettleton on the simplicity of his statements. He was sure that, when his plant had settled down and was in ordinary work, the reported results would be exceeded, and in the latest showing would be even more satisfactory.

Dr. ELLIOTT said that when, some five years ago, he first saw the work of vertical retorts in Europe, it seemed to him to be a step in the right direction; but he had heard some comments in America that had sometimes made him doubt this. However, the more he thought of it, the more he was satisfied that it was in the right direction to have vertical retorts. Mr. Nettleton gave in one place an analysis of coal containing 7·55 per cent. of ash; but he said farther on that the coal yielded 68·57 per cent. of coke. If the coal lost this amount of material, his coke should only contain 11 per cent. of ash. But it contained 12·84 per cent. He (the speaker) did not see where Mr. Nettleton got the rest of the ash. He was speaking as a chemist, and they had to make analyses which totalled up; and this did not tally so closely as it should do. The author said also that the tar contained very little free carbon. This would go to show that it had not been submitted to the usual heat, because this would give more carbon and naphthalene. There was a great deal of scare about naphthalene. It was bad when they had a lot of it. But some of it was a pretty good illuminant; and, if they could only take care of it in the works, and not let it go out into the street mains, they were all right. It seemed to him that the results given were not quite high enough in naphthalene for good candle power. He quite agreed with

Mr. Duckham that care must be taken not to have paraffin. It might be a good thing for tar manufacturers for making pitch; but they did not seem to know how to handle it. He wished to compliment Mr. Nettleton on his splendid exposition of a piece of experimental work well worthy of being copied by all.

Mr. TAUSSIG said Mr. Nettleton had made a very frank statement of his operating results, and he commended him for it. He had given results for eight days, in which observations were only taken in the daytime. He (the speaker) believed these results were probably an average of what would be obtained through the 24 hours; but it left a question as to whether they were accurate if only taken during a portion of this period.

Mr. NETTLETON, referring to Dr. Elliott's remarks, said he was aware that there ought to be only about 11 per cent. of ash, whereas he (the speaker) had found more than 12 per cent. He, however, had simply stated the facts as they were. He asked Dr. Beardsley to make a statement on this matter.

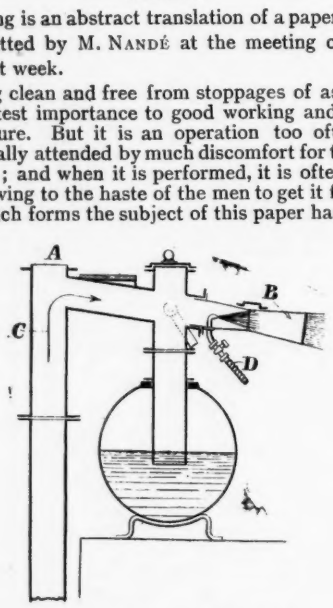
Dr. BEARDSLEY said that prior to the eight-day test they made five analyses of the coke, and the average came out 12·55, against 12·84 in the present case; so that the latter value was evidently regular. He had two possible explanations to offer for it: First, in the grinding-down of the coke, it might cut a certain amount of iron off the tools. The sample was crushed with tamping-irons on a concrete floor, and was further crushed in a ball-mill. They tested it, and found increased iron content, but apparently not sufficient to account for the great difference in the ash. Secondly, the conditions in the vertical retort were different from those in the horizontal types; and it might be imagined that sulphide of lime and magnesia were formed in the process, so that when the coke containing the sulphide was burnt to ash, it was possible that the sulphide might oxidize to sulphate, with a very considerable increase in the weight of the ash as a result. These two possibilities—the increase of iron and the production of sulphate—were the only ways in which he could account for the high ash results; and they found it in every case.

Mr. NETTLETON, replying to Mr. Taussig, said the reason the test was not carried through the 24 hours was the additional expense involved. He felt it would be fair, running over a period of eight days, to take the results obtained in the daytime, assuming that no attempt was made to interfere or change the running at night, as he was sure there was not. He believed these results were practically the same as would have been obtained if the test had been carried on through the whole 24 hours. As to the naphthalene produced, while there was naphthalene in the gas, as was shown by the picric acid test, the quantity was so small that it had not given any trouble around the works or on the street. The condensing apparatus had been run without any regard to the possibility of naphthalene deposits; and, so far as he knew, no naphthalene had been seen since the vertical retorts had been started. There was a very sharp contrast in this respect between the working at Derby and at New Haven.

CLEANING ASCENSION-PIPES.

The following is an abstract translation of a paper on the above subject submitted by M. NANDÉ at the meeting of the Société Technique last week.

The keeping clean and free from stoppages of ascension-pipes is of the greatest importance to good working and regularity of gas manufacture. But it is an operation too often neglected, since it is usually attended by much discomfort for those to whom it is entrusted; and when it is performed, it is often very imperfectly done, owing to the haste of the men to get it finished. The apparatus which forms the subject of this paper has for its object



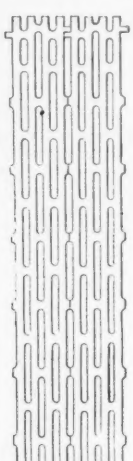
the improvement of the conditions under which such work is performed, and the assisting of the operation. Its application is simple, inexpensive, and absolutely reliable. It consists in drawing-off by means of a steam-jet the flames, smoke, or gas produced by the combustion or distillation of the coal in the retorts—the steam-jet being placed in an attachable pipe in the form of an ejector in any convenient position.

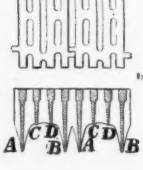
The diagram shows the top of the ascension-pipe with the cap removed from A, ready to receive the cleaning implement. At the same time the hot gases or fumes, in the ordinary course of things, pour out at A, and render the cleaning operations most disagreeable. But the vacuum produced by the ejector and steam-jet apparatus B causes the fumes to follow the direction of the arrow C, instead of issuing at A, where the man is at work. The apparatus is very simple and light, and is fitted with a handle for moving from bench to bench. The steam supply is received through the branch pipe D. The system really only turns away the fumes from their original direction; but the effect of mixing them with the steam is at the same time to throw down the tarry particles with the water of condensation, in such a way that the fumes are, so to speak, absorbed by the apparatus and practically disappear, the hygienic advantages of which are obvious. The author remarks that the apparatus must be fitted in different positions to suit different installations. In the case of through retorts, it can be easily applied at the top of the pipe which is not being cleaned, and will draw all the fumes through this one, and leave the other clear.

Summing-up, the author remarks that the system can be applied in all works, large and small alike. Steam is practically always available, and can be produced, if necessary, by means of a small vertical tube boiler, heated by the hot furnace gases. The same ejector can be used for scurfing retorts, especially in small works where no special apparatus is kept. A diagram is given in the paper showing its application to this operation, by increasing the vacuum and so driving the cold air through the retort—thus precipitating considerably the work of scurfing.

IMPROVED FIRE-BARS FOR GAS FURNACES.

The following is an abstract of the paper read before the Société Technique last week by M. Jacqueson, on a new system of improved grate, intended to replace in combustion furnaces the old system of fire-bars, in which the proportion of air space to solid metal was badly adjusted, and which afforded a too much localized air supply. The new grate has two outside bars, A and B, and two inside, C and D, which are only 7 mm. thick, so that the air can circulate very readily, and is well divided. In this new form of grate the spaces between the bars form 40 per cent. of the total surface, whereas with the old system the percentage was only 23. The advantages claimed for the new system, similar models of which are being used for producer furnaces, are as follows:





1.—The grate is very little affected in use, and the surface remains smooth and flat.
2.—Slag does not adhere so firmly, and cleaning is considerably facilitated.
3.—Combustion is more regular, and considerable economies can be effected in heating.
4.—The piers of the furnace are kept in good condition.

M. Jacqueson, by the simple substitution of these fire-bars for the old ones, has increased the yield of the same coal under identical conditions from 276 to 309 cubic metres.

Commenting on this paper, M. Guillet remarked that for a long time it had been considered absolutely necessary to use thick fire-bars with enormous spaces between. It is, however, quite evident that much is gained by decreasing the dimensions of both fire-bars and spaces, and increasing the air-supply. But fire-bars with small spaces have the advantage of preventing small pieces of coke from falling through into the ash-pan.

Royal Society of Arts Conversazione.

On Tuesday last a conversazione was held in the Natural History Museum, South Kensington, by the Royal Society of Arts. The gathering was a large one. The guests were received by Lord Sanderson, G.C.B., K.C.M.G., the Chairman, and the other members of the Council. Many of the exhibits of the museum were open to inspection, and excellent selections of music, vocal and instrumental, were provided in various parts of the building—the band of H.M. Royal Artillery playing in the central hall. The splendid arrangements all contributed to a most enjoyable evening.

A large party of members of the Society of Engineers (Incorporated) visited the Chingford reservoir of the Metropolitan Water Board last Tuesday afternoon for the purpose of inspecting the reservoir and the Humphrey pumps installed there. Permission for the visit to take place had been given by Mr. W. B. Bryan, M.Inst.C.E., the Chief Engineer to the Board, and by the Humphrey Pump Company, Limited. The visitors greatly appreciated the opportunity of viewing the installation, which has been fully described and illustrated in the "JOURNAL."

CORRESPONDENCE.

[We are not responsible for opinions expressed by Correspondents.]

Hygienic and Heating Efficiency of Gas-Fires.

SIR,—With reference to the letter from Mr. James Wilson and your comments relative thereto, I think it must be admitted that all gas-fires should be so constructed as to carry off at the flue outlet the whole of the products of combustion without any aid from chimney up-draught. But the difficulty arises as soon as the fire is connected to a flue, as perhaps no two flues have an equal pull, and even the same one may vary with every wind that blows. An excess of draught over the "fuel" can hardly do other than carry away a portion of what should be usable heat.

It therefore seems to me that the logical thing to do is to construct fires that will, with certainty, carry off the products of combustion without aid from the chimney, and then get rid of (or perhaps it would be better to say satisfy) any pull there may be from the chimney by a supplementary opening of adequate size.

Personally, I prefer a gas-fire, when used in front of a coal grate, simply fitted with its flue outlet (without piping at all) just under the canopy usually existing. But many prefer that the space around the fire should be closely filled in with sheet iron or other material. In such cases, I think a good plan would be for the fire makers to incorporate a ventilator—possibly of the hit-and-miss type—in the base of their fires, in order that it may be used when necessary to pass air to the chimney, and thus avoid any pull, with the consequent excessive passage of air through the fire outlet, and at the same time maintain the adequate ventilation of the room.

It is fatal to the use of gas-fires in general if their type or method of fixing in any way interferes with the free ventilation of the apartment; and I think the method that I suggest would provide this and at the same time maintain the full efficiency of the gas-fire.

I should like to add, before closing, that some manufacturers of gas apparatus, when making their own claims, altogether fail to remember the part played by Messrs. Wilsons and Matthiesons in the improvement of gas-fire design and construction.

R. B. A.

June 19, 1913.

Pitting of Steel Mains.

SIR,—With further reference to my recent letter *re* the pitting of steel mains in Port Elizabeth [*ante* p. 602], since writing many new holes in pipes have been, and are being, found daily, and also evidence of bad pitting action on the water pipes now being cleaned and bitumenized. The general opinion here is that the whole of the mains will have to be renewed. These mains, I might say, are from three different firms or makers.

I enclose a cutting containing a new theory, which is of great interest, in regard to the quality of the steel or iron at present turned out as compared with metal made years ago.

WILLIAM ARNOTT.

South African Lighting Association, Limited,
Port Elizabeth, June 2, 1913.

[ENCLOSURE.]

Old Iron v. New Steel.

In a paper read by Mr. H. Kempe, and recently published by the British Institution of Post Office Electrical Engineers, light is thrown upon a matter which may have an important bearing on the question of our steel water-mains. It is often stated that the iron hulls of ships built forty or fifty years ago are, so far as metal is concerned, in nearly as good condition as when delivered; whereas a modern steel boat, after twenty years' use, is barely worth re-boilering. Mr. Kempe, in tracing the history of the first cross-Channel cable, put forward a suggestion which in part, perhaps, answers the riddle. The sheathing of the 1851 cable, made from the best quality of iron then available, is still in use; and Mr. Kempe, on comparing the old with the later and better quality brands, came to the conclusion that, though the latter were undoubtedly mechanically stronger, it was not good policy to sacrifice durability to strength, especially in those manufactures where the breaking strain of common iron, though less than that of what is practically steel, is still much in excess of requirements. As a result of Mr. Kempe's investigation the latest cable (Anglo-Belgian), though a furnace had to be specially built for the production of the out-of-date description of metal, has been sheathed with the old quality iron, with entirely satisfactory results. Mr. Kempe, of course, speaks for cables only, and his deductions, however sound, may only be partly applicable to shipbuilding and other industries. But, in the modern craze for scrapping, may we not be perhaps rather too prone to exchange old lamps for new ones? The fact that one important article, termed inferior iron, holds the field, and that its manufacture had to be revived, gives food for thought.

The Hygienically Perfect Fire.

SIR,—I believe the time has arrived for me to make a further appeal to the makers of gas-heating appliances to study the principles upon which construction must progress, if we are to attain hygienic perfection and thermal efficiency.

In my opinion, the water-heaters recently introduced by the Richmond and Parkinson Stove Companies indicate the beginning of a development in the use of gas which is likely to have very far-reaching effects; and these appliances interest me as constituting the first commercial development of a principle which I illustrated a year or two since in your columns—in the form of a direct gas-heating device for motor houses or small rooms.

The principle is, of course, not quite novel—being substantially that of the Clark syphon stove; but it possesses the advantage of hygienic perfection, by carrying the burnt gases to the open air, and at the same time avoiding the possibility of back-draughts. There is no reason why these water-heaters should not equally be made to attain hygienic perfection by means of suitable flues for the air supply and the burnt gases.

It is somewhat surprising that no manufacturer appears to have seen, in my previous communication and illustration, the elements of a self-contained gas-heated radiator of positively maximum efficiency.

The application of this thermo-syphon principle is one that is by no means of necessity limited to the use of town's gas for household purposes; and my own experiments would indicate that there is no reason whatever to prevent its successful application to the economical production of steam from producer gas heat on lines that are not covered by any existing patents, or that would be covered in principle by future patents. The principle, of course, allows of heat abstraction from the burnt gas to a point approximating the temperature of the feed water in almost the same manner that we abstract heat from gas in the Junkers type of calorimeter.

The system possesses peculiar advantages in respect of condensation upon, and corrosion of, the heated surfaces, because all condensed liquids are at once carried away to the point of exit of the flue gases, and give up their heat of condensation to the heating surface.

The very slow commercial advance of recent years in truly economical gas heating, and the obvious possibilities of the thermo-syphon and enclosed gas-circulation systems, prompts one (at the risk of repeating what I may have said some time ago) to suggest once more the consideration of a subject which concerns the advance of your industry as a whole, while it interests me only as a theoretical proposition which ought to have a real practical application.

J. H. LESTER, M.Sc., F.I.C.

Manchester Chemical Club, June 21, 1913.

PARLIAMENTARY INTELLIGENCE.

HOUSE OF LORDS.

The following further progress has been made with Bills:—

Bill read a second time: Tottenham and Edmonton Gas Bill.

Bills reported: Bishop's Waltham Water Bill, Gas and Water Orders Confirmation Bill (No. 1), Mynyddislwyn Urban District Council Bill, Worthing Gas Bill.

Bills read the third time and passed: Broadstairs and St. Peter's Urban District Council Bill, Huddersfield Corporation Bill, Tynemouth Gas Bill.

HOUSE OF COMMONS.

The following further progress has been made with Bills:—

Bills brought from the Lords, read the first time, and referred to the Examiners: Broadstairs and St. Peter's Urban District Council Bill, Huddersfield Corporation Bill, Tynemouth Gas Bill.

Lords Bill read a second time and committed: Bradford Corporation Bill.

Bills reported: Blyth and Cowpen Gas Bill [Lords], Heathfield and District Water Bill, Redcar, Coatham, Marske, and Saltburn Gas Bill [Lords].

Bills read the third time and passed: Gas and Water Provisional Orders Bill (No. 2), Northampton Corporation Water Bill [Lords], Silloth Gas Bill.

Bill withdrawn: Brumby and Frodingham Urban District Council Bill.

REDCAR, COATHAM, MARSKE, AND SALTBURN GAS BILL.

This Bill was last Thursday before the Unopposed Bills Committee of the House of Commons, and was ordered to be reported.

Mr. Fox (of Messrs. Durnford and Co., Parliamentary Agents) said that the Bill was promoted by the Redcar, Coatham, Marske, and Saltburn Gas Company, and provided for the construction of additional works, the reduction of the illuminating power from 14 to 12 candles, and the increase of the borrowing powers. In regard to the candle power, he explained that 12-candle power gas was supplied in the neighbouring town of Middlesbrough; and one of the reasons for the change in the present case was that 97 per cent. of the consumers employed incandescent mantles, and 67 per cent. used cookers and heaters. A petition at one time was entered against the Bill by the Redcar Urban District Council, who asked for a calorific test, in view of the reduction to 12-candle power. The Company had agreed to give the same calorific standard as the Gaslight and Coke Company, and had inserted the Wandsworth calorific test clause, with the exception that, whereas in the original Wandsworth clause the value was in gross calories, in the case of the Gaslight and Coke Company it was net. Therefore the Wandsworth clause had been inserted in the Bill, with the value in net calories.

The *Chairman* of the Middlesbrough Corporation Gas Committee was called to give evidence to the effect that no complaints had been received in the district, where 12-candle power gas is supplied.

Mr. *Jacques Abady* said that in March last he visited the Redcar Company's works, and tested the calorific value of the gas. The gross calories were 153, and the net, 137. At Middlesbrough the figures were slightly higher—156 gross and 139 net. A subsequent surprise visit to Middlesbrough gave test figures which confirmed the previous ones. A test of the candle power at Middlesbrough showed it to be between 12 and 13, while at Redcar a candle power test made with rather out-of-date apparatus was judged to give a result of about 15. As comparative figures, he mentioned that tests in 1910 of the Gaslight and Coke Company's gas gave net calories of 122·9, and the candle power 15, while in 1912 the figures were 120·6 and 14·5 respectively.

Similar figures for the Commercial Gas Company in 1912 were 122 and 14·89 respectively.

Mr. E. Moon, K.C. (the Speaker's Counsel), called attention to the growing practice of gas undertakings coming to Parliament for authority to decrease their candle power, and suggested that it might not be fair to the consumers.

The Chairman (Mr. Whitley) said that if the practice continued to grow it might be necessary to make inquiries into the matter. Probably when the next case came before Parliament some evidence would be given on the question generally; but he did not think the Committee could take the step of refusing the decrease in this instance.

PROGRESS OF SUNDRY PRIVATE BILLS.

The following Bills were before various Committees of Parliament during the past week, and were sent forward for third reading.

Blythe and Cowpen Gas Bill.—This measure was before the Unopposed Bills Committee on Thursday. The object of the Bill is to enable the Blythe and Cowpen Gas Company to acquire the undertaking of the Bedlington Gaslight Company, who are at present supplying, as a non-statutory company, in the adjoining district of Bedlington. At one time there was opposition by the Bedlington Urban District Council; but that body were now satisfied with the Bill. The purchase price is £7500, *plus* the capital expenditure since May 20, 1911. The Blythe and Cowpen Gas Company have changed their name to the Blythe Gas Company, on the amalgamation of Cowpen with Blythe.

Gas and Water Orders Confirmation (No. 1) Bill.—Included in this Bill, which was before the Unopposed Bills Committee, were among others the following Provisional Orders: (1) Bagnalstown Order, which is dealt with elsewhere. (2) Dronfield Order, which extends the powers of the Dronfield Gaslight and Coke Company. The candle power is specified as 14; and the remaining clauses in the Order are in line with modern gas legislation. (3) Alresford Water Order, by which the Alresford Water Company are authorized to raise £2000 of additional capital. (4) Portsmouth Order, by which the Corporation are empowered to extend their limits of supply.

Worthing Gas Bill.—This Bill was before the Unopposed Bills Committee of the House of Lords on Tuesday. Its promotion was rendered necessary by the inability of the Company to lay mains through a tunnel belonging to a private owner, who refused to give his consent, and who maintained his rights subsequently in the Law Courts, as reported in the "Journal" at the time. The Company have laid their mains up to either side of the tunnel, which crosses a main road, and the Bill provides for completing communication between them. There are certain protective clauses for the owner of the tunnel.

BAGNALSTOWN GAS ORDER.

The Gas and Water Orders Confirmation (No. 1) Bill, in which is included the Bagnalstown Gas Order, was, on June 16, before a House of Lords Committee presided over by the Duke of Bedford. The Order was opposed by the Carlow County Council and the Town Commissioners of Bagnalstown.

Mr. R. B. Anderson, the General Manager of the Bagnalstown Gas Company, appeared in person; while the Carlow County Council and the Town Commissioners of Bagnalstown were represented by Mr. J. A. R. Cairns.

Mr. Anderson explained that the Company is a very small one, with an expended capital of rather less than £3500, and supplying about 3,000,000 cubic feet of gas per annum. The gas-works were constructed sixty years ago. The present management was formed into a Company about seven years ago, and had since spent about £1000 in improvements. The population of the town, according to the last census, was only 1882. Before the Company came under the present management, the price charged was 7s. 1d. per 1000 cubic feet. This has been reduced to 5s. 6d., with lower prices for cooking, heating, and motive power. The Order increases the capital of the Company by £3172, limits the dividends on the capital to 10 per cent. on the original ordinary capital and 6 per cent. on the original preference capital, and to 7 per cent. on the additional ordinary capital and 6 per cent. on the additional preference capital. Powers are also given for the purchase of additional lands, and for the maintenance of works, &c., upon them. The standard price is now fixed at 5s. The petitioners objected to the Order being confirmed, and suggested that the price under it was excessive. He did not propose to call a number of witnesses; but as he was the General Manager, he would ask to be allowed to go into the witness chair himself.

Mr. *Anderson*, as witness, stated that under the old management, in addition to the price of gas being high, the town was lit by inefficient burners; but the works had now been reconstructed. The Order defined the capital, limited the dividends, and the price of gas was determined, subject to a sliding-scale. Under the Order the standard price was to be 5s.

Mr. Cairns then cross-examined witness, and brought out the fact that Mr. Anderson's family were shareholders in the Company, and that if there was any material advantage to the Company it would go to witness's family; while the only benefit that the consumers themselves would get would be the extension of the town lighting. There had never been any difficulties between the Company and the local authorities. If he had the powers now asked for, witness said he would be able to maintain a more efficient supply than in the past.

Mr. Cairns then addressed the Committee, and said it seemed to him perfectly clear that it was impossible to allege that any case had been made out for the Order, and he could see no reasons whatever for the concession of these powers upon the Company.

Mr. *William Byrne*, Solicitor to the Carlow County Council, was called to give evidence against the Company with regard to the price to be charged. He suggested that a charge of 6d. per 1000 cubic feet more than the price of gas in Carlow—viz., 3s. 9d.—making it 4s. 3d. in Bagnalstown, would be a reasonable charge.

Mr. Anderson cross-examined, and got from witness the admission that he did not know the price of gas in any other places in the neighbourhood except Carlow and Bagnalstown, and therefore, he contended, witness was not in the position to say what the price in Bagnalstown should be. He pointed out to witness that Carlow was quite an exceptional town as regards the price.

Mr. Cairns, in re-examination, pointed out that the facilities for getting coal in Carlow and Bagnalstown were about equal.

Mr. Anderson, addressing the Committee, stated that the Board of Trade had held an inquiry regarding the Order, and considered that it should be confirmed.

The Committee consulted in private, and

The Chairman announced that they were of opinion that the Order should be confirmed.

LEGAL INTELLIGENCE.

NORTH SUSSEX GAS AND WATER COMPANY.

A Winding-Up Petition.

A petition presented by A. F. Painter for the compulsory winding-up of this Company was heard by Mr. Justice Neville in the Chancery Division of the High Court of Justice last Tuesday.

Mr. Clauson, K.C. (with him Mr. Willis), said petitioner was an unsatisfied judgment creditor who asked that the Company should be compulsorily wound up. No notice of opposition had been given except by debenture-holders, who were in possession by a receiver. The Company opposed; but he should submit they had no *locus standi*. The Company was formed under Private Acts of Parliament for the purpose of carrying on a gas and water undertaking in North Sussex; the Company being promoted by one Preston. Petitioner commenced an action on July 3, 1911, and recovered judgment for £253 and costs in January, 1912. In May, notice was served on the Company demanding payment; but the judgment was wholly unsatisfied. Evidence had been filed on behalf of the Company suggesting that petitioner was not a person who could be relied upon in engineering matters. But what this had to do with the case he could not possibly understand, as the only issue was whether or not the petitioner had a right to a winding-up order. The concern was only being carried on for the benefit of the debenture-holders.

An affidavit made by the Secretary (Mr. Beeby) was read, in which it was suggested that petitioner was a nominee of Preston, and had acted as engineer for many of his undertakings. Petitioner had filed an affidavit denying these allegations in the strongest terms, and stating that his debt was in respect of work done and services rendered.

His Lordship said he thought the affidavits filed on behalf of the Company were "scandalous." Petitioner was an unpaid creditor, and it was no answer to the petition to say that he was a bad man. Even bad men were entitled to be paid.

Mr. Gore Browne, K.C. (with him Mr. Marten), for the Company, said he could not say the affidavits were relevant. Dealing with the merits, he submitted that the Court would not make an order for winding-up when no possible good could result to the creditors by so doing. Being a statutory company, it would be necessary to obtain an Act for its dissolution.

His Lordship: Statutory companies must pay their debts.

Mr. Gore Browne said if the Company were given time, they would be able, by good management, to pull round and pay all their debts. A winding-up order would really prejudice the security of the debenture-holders.

His Lordship asked whether the petitioner would be satisfied if he was paid within a week.

Mr. Clauson replied in the affirmative.

His Lordship said he was bound to make the order, but he would direct that it should not be drawn up for a week; and if the debt and costs were paid within that time, it would not be drawn up at all. He also directed that the affidavits put on the file on behalf the Company should be taken off, on the ground that they were scandalous.

CHARGE FOR WATER USED BY BUILDERS.

The Court of Appeal, consisting of Lords Justices Vaughan Williams, Buckley, and Hamilton, were engaged last Tuesday and Wednesday in hearing an appeal by the defendants in an action brought by the Metropolitan Water Board against Messrs. Johnson and Co., builders.

The initial proceedings were taken in the Westminster County Court to recover the sum of 14s. for water used by defendants in erecting certain buildings at Hounslow Barracks. The Board claimed under section 17 of their Charges Act; the amount being calculated at the rate of 7s. per cent. on the probable cost of the building. In 1911, the defendants, under a contract with the War Office, erected a building at the barracks; and it was a term of the contract that the water necessary for use in the operations should be supplied free of charge—water used by them being obtained from the supply to the barracks, which was paid for by meter in the ordinary course by the War Office. The County Court Judge found in favour of the plaintiffs. An appeal to the Divisional Court, composed of Justices Channell and Avory, was dismissed, as the Judges were divided in opinion—Mr. Justice Channell thinking the appeal should be allowed; while Mr. Justice Avory thought it should be dismissed. Leave was, however, given to appeal further. [See "Journal" for Dec. 3, 1912, p. 772.]

Mr. Danckwerts, K.C., appeared for the appellants; Mr. Clavell Salter, K.C., represented the respondents.

Their Lordships unanimously allowed the appeal, with costs. They said there had been a long discussion as to whether certain sections of certain Acts of Parliament had, by reference, been incorporated into the Charges Act so as to have effect; these being sections

which showed that, under certain circumstances, damages or penalties might be recovered from persons in the position of appellants. No question of the kind was argued before the County Court Judge; and therefore they had nothing to do with it. The action was brought for debt, or contract, on the ground that there was a contractual relation between the parties. The only question for the Court was what was the proper construction of the Act of 1907 and of the contract of 1909; and as a decision on the first point was sufficient to dispose of the case, it was not necessary to deal with the second. The word "require," in section 17, did not mean "has occasion for," but rather "asks for, demands, or requests," and indicated that a person might be supplied by meter under the provisions of section 16. The appellants took the water from the tap of the War Office; and as the Water Board thought this was wrong, they made a demand which they were not entitled to make. In fact, the effect of their action was to make both the appellants and the War Office pay for the water consumed. There was no foundation for the contention that there was any contractual relationship between the appellants and the respondents. Their Lordships thought the decision given by Mr. Justice Channell as to the construction to be placed upon section 17 was the correct one.

ABNORMAL PRESSURE AND AN ABNORMAL BILL.

At the Maryport Police Court on Friday, a case was heard which excited much interest among local gas consumers. During the Christmas quarter of last year, an increased consumption and complaints of low pressure led to the Council ordering further pressure to be used. The result was that many of the consumers found their bills increased, and there was much grumbling. Some of them applied for a rebate; but this the Council refused, on the ground that, as the consumers taking their gas through prepayment meters and others had paid, it would be unfair to grant a rebate to the large consumers, after the small consumers had paid. Subsequently all who objected to their accounts paid except Messrs. John Williamson and Sons, Limited, tanners, who were summoned by the Council for £17 2s. 3d., being the charge for 100,500 cubic feet, at 3s. 4d. per 1000 feet, and 7s. 2d. meter-rent for the quarter ending Dec. 31, 1912.

In opening the case, Mr. Crerar (for the Council) said the Local Act of 1877 incorporated the Gas-Works Clauses Act of 1871, which, under section 20, provided that the quantity registered by the meter should be reckoned as the gas consumed. Under this Act, it was provided that there must be such pressure as would balance from midnight to sunset a column of water not less than 6-10ths of an inch in height at the main, and from sunset to midnight a column of water not less than 8-10ths of an inch in height at the main. But there was no maximum pressure defined by the Act. The Council could only accept what was registered by the meter, because there might have been leakage or overtime; and as the gas for which they were suing had been actually consumed, he submitted there was no answer to the claim, and the Justices were bound in law to make an order.

The evidence was to the effect that there were five meters, which totalled for the quarter in question 100,500 cubic feet. The figures for the corresponding quarter were 65,900 feet, so that there was an increase of 34,500 feet, or 52·5 per cent. One witness said the defendants had not suggested to him that the excessive consumption was due to abnormal pressure. He had heard rumours from consumers, and had no doubt that the reason why defendants objected to the charge was because they believed it to be due to abnormal pressure; but they did not complain to him personally. As far as he knew, no warning was given the consumers. Defendants had applied for a rebate, which had not been allowed. He did not know that, owing to the unfair way the consumers had been treated, there had been an increased profit on the gas-works somewhere in the neighbourhood of £1000.

Addressing the Bench for the defendants, Mr. Lightfoot commented on the absence of the Gas Manager. He said his clients regarded this charge as a gross imposition, which they would not submit to without bringing their position, and that of other consumers, before the Court. An increase of 52·5 per cent. was an extraordinary one; and Messrs. Williamson were perfectly right, in the public interest, in resisting it. The Council had furnished them with a reason for this increased consumption. There were complaints of low pressure, which came before the Council; and they gave instructions for the pressure to be increased. The Manager at once rushed to the other extreme, and forced the gas through the pipes, causing an unnecessary consumption, at the consumers' expense. There was no warning whatever given. The unfairness being recognized by a section of the Council, some of the consumers applied for a rebate; but it was refused, merely on the ground that the other consumers had paid, and it was impossible to adjust the bills. This was not a dignified position for the Council to occupy; and he submitted they were very much at fault. His clients had not the smallest misapprehension of the position they occupied in law. He had advised them that, however unfair the position in which they found themselves, the Council were entitled to recover the bill; but out of duty to themselves and the public, his clients were not going to pay until they had brought the matter to Court, and been able to explain to the Justices, and through them to the public, the position with which the consumers were faced owing to the erratic management of the gas-works by the Council. The Council discussed the question of rebate; but the only remedy they suggested was that his clients should exercise greater control over their meters. His clients had, however, a better remedy than this. They would cease using the gas. Under the Gas-Works Clauses Act of 1871 they were not absolutely helpless, because provision was made for the appointment of a gas examiner on the application to the Justices of not less than five consumers. It would have been a simple matter to secure four other consumers to support the application. But it would have resulted in considerable expense, which would ultimately have fallen on the gas consumers; and his clients were the last people in the world to desire this. In fairness to the Council, he might say that the last bills showed only an increase of 6½ or 7 per cent. on the corresponding quarter—indicating that infinitely greater care was being exercised.

An order for payment was made.

MISCELLANEOUS NEWS.

ILKESTON GAS MANAGEMENT.

Mr. F. C. Humphrys' Revelations.

To the discomfiture of his critics, whose action cannot be said to have erred upon the side of generosity, Mr. F. C. Humphrys availed himself of the opportunity afforded by a special meeting of the Ilkeston Town Council last Tuesday to lay bare publicly the circumstances connected with the erection of the spiral-guided holder, the demolition of which had formed the subject of a Government inquiry. For too long a period he had been considerate enough to bear vicariously the responsibility for a process which had been officially characterized as that of "hoodwinking" the Local Government Board; this condemnation having followed upon the admission which was forthcoming to the Inspectors that the plans upon which application for permission to borrow money was based were departed from in an important particular by the substitution of a steel tank for the safer brick and puddle arrangement originally proposed—a change which, by reason of risky factors involved, was shown to have directly contributed to the disaster. Mr. Humphrys' explanation makes it clear that the process of putting the work in hand had, against his better judgment, been so long delayed as to involve serious danger to the continuity of the town's gas supply, and that it was only when the inevitable difficulty entailed by needless procrastination had to be met, that the alteration was decided upon, in order to save valuable time. Instead of there being any justification for the insinuation that the responsibility for the act was purely of an individual character, Mr. Humphrys established that every step taken was with the direct authority of the members of the Committee specially concerned. The fact that the alteration of plans was not clearly explained to the Inspector was one for which the responsibility obviously devolved upon the late Town Clerk, who had the conduct of the whole proceedings. Mr. Humphrys' province was necessarily limited to explanation of the engineering details involved; and the attempt now to make him responsible for the legal framing of the case involves a consideration which raises an important point of professional practice not limited in its application to the Ilkeston case. In view of the thirty-eight years spent in the service of the Ilkeston Corporation, the attempt to put the responsibility upon the wrong shoulders appears, to say the least of it, to be specially ungracious in Mr. Humphrys' case. The matter, however, not having apparently been finally disposed of by the central authorities, the hope is not unreasonably entertained that some means may yet be devised whereby justice may be done.

Mr. HUMPHRYS prefaced his explanation to the Council with an expression of thanks for the opportunity they had afforded him of attending before them, and replying to some of the statements which appeared to have been pretty freely made against him. Many of these, however, were so vague or indefinite that it was extremely difficult to meet them or clearly define their real extent. He proposed, therefore, to deal with the published reports of the last Council meeting, as there, for the first time, so far as he was aware, questions arose which dealt with his personal honour. Let him say, at the outset, and as plainly as he possibly could, that though during the long period of thirty-eight years he had been in their service errors of judgment which were common to all of them might have been committed, he had had throughout but one aim and object in view, and this had been the welfare and progress of the department under his care; and he denied in the strongest manner that any question of personal gain, anything dishonourable, unjust, or corrupt, had anything to do with any recommendation he had ever put before the Gas Committee. He appeared to be charged with keeping back or suppressing information. It was quite possible that the real meaning of a question might not always be fully grasped, and the answer given was therefore incomplete; but he certainly denied that there had been any deliberate attempt on his part to hide material facts, and most certainly not with any ulterior motive. Immediately after the accident to the gasholder, copies of every letter sent to, or received from, the contractors were taken, and subsequently, before the Coroner and the Home Office Inspector, he was examined under oath for several hours; so that he certainly thought the Council, at any rate, were in full possession of all essential details.

HISTORY OF THE MATTER.

Coming to details, he explained that the incidents went back to thirteen years ago; the Council having in 1900 decided that the time had arrived when it was necessary, owing to the increase in business, to remodel the gas-works. The most urgent parts were accordingly dealt with at that time, and included purifying plant, exhausters, sulphate works, and meter-house. As the whole of the apparatus was in successful operation, this part of the work needed no further reference. Seven years later, on May 30, 1907, at a special meeting of the General Purposes Committee, he submitted a set of plans which comprised the rest of the scheme, and included retort-house, coal and coke handling plant, and a gasholder and tank. These had previously been considered in detail by the Gas Committee, and were, after discussion and explanation, approved, and the usual applications for sanction directed. The amount involved being a large one, the scheme had been purposely delayed as long as possible; and now, to ensure the continuity of supply as well as the economical working of the department, it was absolutely necessary for the work to be put in hand as early as practicable. As the winter of 1907-8 proceeded, it was evident that the surmised difficulties were very real ones; and at each meeting of the Committee he called attention to this urgent necessity. A special meeting was called for Jan. 9, 1908, and it was then decided, in order to expedite matters, to invite tenders for the gasholder and tank; also to send to the Local Government Board a deputation consisting of the then Mayor (Alderman F. Sudbury), the late Town Clerk, and himself. At the meeting he reported that as a steel tank would take less time to construct, it would offer one solution of their then awkward position.

The deputation went to London on Jan. 20, 1908, and during the day the possibilities of the steel tank were fully discussed; and it was agreed that he should invite alternative tenders, so that the Gas Committee should be in possession of the fullest information possible on the subject. In this connection, he desired it to be made quite clear that each step taken up to this point was known to the Mayor, the late Town Clerk, Alderman F. Beardsley, and Councillor W. Tatham, the Chairman and Vice-Chairman of the Gas Committee, whom he often met in conference, and also to such members of the Committee as attended the various meetings; that no one outside these had any knowledge of what was being done, or had any connection with the business in any shape or form; that no outside engineer had anything to do with the change in the type of tank or with the selection of contractors; and that the tenders were ready for the meeting of the Gas Committee held at the end of February. It was March, however, before they were actually considered; and a special meeting was called for the 25th of the month, at which he deemed it his duty to place before the Committee the serious position the works were in owing to the continued delay, and also that unless something was done at once there would be no chance of getting the holder into work for another winter, and that even to do this it would be necessary to adopt a steel tank. After considerable discussion, it was decided to adjourn the meeting until March 31, when it was agreed that the type of tank should be altered. The whole of the tenders were considered and four selected. As some were several weeks old, he was instructed to write to each of the four firms, asking them if they were still willing to accept the work at the prices quoted. This accounted for the further delay of two days; and eventually, on April 2, 1908, the tender of Messrs. C. & W. Walker for £5114, as originally sent, was accepted by the Committee, and afterwards confirmed by the Council. This tender was for a gasholder with two lifts; provision being left for a third lift to be added later. The site had to be prepared and the concrete base put down. The governor, valves, pipes, and connections were the subjects of separate contracts; and these items must be added to Messrs. Walker's contract to arrive at the actual cost of the work. With regard to the £8000, the borrowing of which was sanctioned, this included £1200 for an additional lift to be added when required—say, in ten or fifteen years. The deduction of this amount left the balance to be accounted for £6800. The price of the gasholder and steel tank, as already mentioned, was £5114. The governor and governor-house connections and the cost of cleaning and preparing the site had accounted for a further £1450, which brought up the total to £6564. This being deducted from the £6800 left only a balance of £236, which sum, if it were not spent, would certainly not be borrowed. Looking at it from another point of view, if they took the estimate which would probably have been accepted for a brick and puddle tank as £2750, and for the gasholder as £2600, they had a total of £5350. The actual sum spent for the steel tank and holder was £5114; and the point he wished to emphasize was that the steel tank and holder only cost £236 less than a brick and puddle tank and holder would have done. The next question had reference to the inquiry that followed in about six weeks. At the conference which always preceded such an inquiry, the Town Clerk said he did not propose to call the attention of the Inspector specially to the fact that they had changed their plans from one standard form to another that was more modern and much more largely used; and this was repeated on the morning of the inquiry in the presence of Alderman Beardsley and Councillor Tatham. The new plans were then on the table. In concluding this part of the question, he might say that the information which he had laid before the Council was founded on their own minutes, and could be checked by them. The principal other matter to which reference had been made was to his being a Director of the neighbouring Langley Mill Gas Company. He had been a member of that Board for twenty-two years, and was one of seven Directors. He was not, nor ever had been or professed to be, either Managing-Director or Consulting Engineer. The fact had been well known in the town and to the members of the Corporation. The matter was on one occasion brought before the Council and referred to the Gas Committee. That body, after consideration, decided that there was no reason whatever why he should not continue to hold the office, and gave him permission accordingly. Concluding, Mr. Humphrys said: I propose now to leave the whole question with you, and through you to the ratepayers outside, confident of the fact that the more it is considered the more evident it will be that base and unworthy motives have had no part in anything that has been done by me. On the contrary, my life and manner of living for practically a working lifetime go surely to prove that during this long period I have ever been actuated by one desire, and that is to act to the very best of my abilities, in the best interests of the department committed to my charge.

Statements of such an inexact character have gained currency, during the progress of the controversy, regarding the circumstances attendant upon the construction of the holder, that it was not surprising to find the corrections were not limited to Mr. Humphrys' personal explanation. During the course of the meeting, a letter was read from Mr. J. Ferguson Bell, of Derby, who, with Mr. Samuel Glover, of St. Helens, had been called in to advise the Corporation after the accident. Writing to the Town Clerk, Mr. Bell said:

Dear Sir,—My attention has been called to some observations made by Councillor J. A. Macdonald at a meeting of the Ilkeston Town Council, held on the 3rd inst., in which my name was introduced. I cannot understand on what grounds the suggestions made were founded; but I am sure the Council will desire that I should not remain under untrue imputations. I should be, therefore, much obliged if you would be good enough to inform them that I was never consulted, directly or indirectly, by Mr. Humphrys or anyone else with regard to the gasholder and tank in question. I never knew they were being erected, and consequently could not know by whom. It is correct that a few shares stand in my name in Messrs. C. & W. Walker, Limited, but my interest in them is very slight. In fact, the actual position is that I never heard of the intended construction of the tank and gasholder, and I had never even seen them until called in by the Corporation after the accident.

There was also another request laid before the meeting, in the form of a letter from Mr. J. P. Andrews, of the Langley Mill Gas Company (who was present with Mr. Humphrys); this being for permission to refute the charges and insinuations made at the last Council meeting by Councillor J. A. Macdonald in reference to Mr. Humphrys and his association with the Langley Mill Company, but

Mr. Macdonald at once moved that the request should be refused, and that Mr. Andrews should be informed that the Council resented interference in the matter. The Langley Mill Company had, he contended, not been maligned by any remarks which he had made.

Mr. S. Shaw also agreed that it would be wrong to allow anyone to come between Mr. Humphrys and the Council in the matter.

Mr. S. J. Chadwick, in the course of subsequent discussion, observed that no charge had been made against Mr. Andrews.

Thereupon the latter rose to make an explanation.

The Mayor, however, ruled that Mr. Andrews could not speak at that point.

Mr. Andrews retorted that he would say what he had to say outside, if he could not speak in the Council Chamber.

Mr. Smith contended that if, after the slanderous statements which had been made against Mr. Humphrys, Mr. Andrews was not allowed to make an explanation, the only conclusion possible was that the Council were afraid of the truth. He believed that Mr. Andrews was in a position to clear Mr. Humphrys of the foul charges which had been brought against him relative to his connection with the Langley Mill Gas Company.

Alderman H. Moss supported Mr. Smith's demand, and moved that Mr. Andrews be heard.

Mr. Smith seconded this proposal.

Alderman Sudbury said, while it might be considered in the nature of an interference if Mr. Andrews were allowed to speak upon that which was a matter affecting the Council only, a very bad impression might be created among the townspeople if he was not heard. He (Alderman Sudbury) suggested that, before the matter was decided, Mr. Andrews should commit his points to paper.

Thereupon Mr. Andrews handed to the Mayor a list of the points involved, including reference to the question of Mr. Humphrys being a Director and Consulting Engineer to the Langley Mill Gas Company, the Provisional Order, the question whether information was carried from Ilkeston to Langley Mill, to the sale of residuals, and the alleged withholding of information as to a certain contract which was not particularized.

The Mayor said that, so far as he knew, there had been no charge made about carrying information from Ilkeston to Langley Mill; and therefore it was hardly a matter upon which they could desire Mr. Andrews to speak.

Eventually, the Council resolved to defer, until after Mr. Humphrys had given his explanation, their decision upon the point whether or not Mr. Andrews should also be heard.

Mr. Humphrys having then made his statement said, in reply to a question, that while the new plans were upon the table at the Government inquiry, they were not opened out. Answering Mr. Macdonald, he added that permission was given to him about twelve years ago regarding the Langley Mill directorate, although it was not placed on the minutes.

Mr. Sutton: Was it your duty to notify the Local Government Board of the change of plans for the gasholder and tank?

Mr. Humphrys: Certainly not.

Mr. Woolley: But when the inquiry took place, was it your duty, as engineer, to hold back plans you knew you were going to work from, and place before the Inspector the old plans? What made you take that serious step?

Mr. Humphrys: It is not exactly correct to say that the resolution to change the plans contained any reference to the Local Government Board.

The Town Clerk referred to the minute of the proceedings on April 2, which set out that Messrs. C. & W. Walker's tender should be accepted provisionally.

Mr. Humphrys added that his impression was that the contracts were to be let provisionally upon authority being obtained to borrow the money. The then Town Clerk said they were simply changing from one type of tank to another, and that there was no reason to interfere with the plans. The Town Clerk was the mouthpiece of the Corporation when the inquiry took place. It was not for him to say: "The Town Clerk is wrong. There are the plans. The case is being put in the wrong way."

Mr. Macdonald remarked that if Mr. Humphrys had given these answers before, and been candid, the present meeting would have been quite unnecessary.

Mr. Humphrys, in reply to a question as to whether anybody had influenced him in favour of putting down a steel tank, said he might have received advice, when attending meetings, or when he met neighbouring engineers. He had men competent for the class of work involved in regard to laying down a bed for the steel tank.

Mr. Macdonald asked whether, having regard to the fact that Ilkeston is undermined with colliery workings, and liable to subsidence, Mr. Humphrys obtained advice as to how to put this concrete bed down.

Mr. Humphrys replied that the base was as sound to-day as when it was put in.

Mr. Robinson: The Home Office Inspector's report said the Council were ill-advised in not calling in a specialist. It was the Town Council's fault, according to that report.

Mr. Humphrys, reverting to the incidents at the Local Government Board inquiry into the application for sanction to borrow money for the work, stated that the then Town Clerk said he did not propose to specially call the attention of the Inspector to the change of tank.

Mr. Macdonald: Had you not the cautiousness to say: "It will recoil upon you"?

Mr. Humphrys: It did not strike me so.

Mr. Macdonald: Did you quietly submit to what the Town Clerk asked you to do without making the slightest demur?

Mr. Humphrys: What am I? I am simply a paid servant of the Corporation. I am not going to defend what was done; but it did not occur to me at the time.

Mr. Smith contended that the major portion of what Mr. Macdonald

stated at the last meeting of the Council was "a tissue of unwarranted, scurrilous, and dastardly insinuations and charges," which neither he nor anyone else could support by facts. Nothing had occurred to shake his (Mr. Smith's) confidence in Mr. Humphrys, who had known about the use of steel tanks for twelve years. It was very easy to say the tank would not have burst if one of brick and puddle had been constructed; but there had been nothing forthcoming to show that Mr. Humphrys was wrong at the time in recommending the adoption of a steel tank. He added that he had ascertained from Mr. Humphrys that a few days before the inquiry of five years ago the then Town Clerk told him that he did not consider it necessary to send the altered plans to the Local Government Board. When the day of the inquiry arrived, however, Mr. Humphrys took with him all the plans of the altered tank, which he placed upon the table. Just before the inquiry commenced, Mr. Humphrys was, however, again told by the Town Clerk that he did not think it necessary to mention to the Inspector the fact that the type of tank had been altered, but that if it was he would deal with the matter himself. In conclusion, he contended that Mr. Macdonald's charges had been proved to be utterly baseless and unworthy.

The resolution in favour of Mr. Andrews being allowed to address the Council was then put and lost; only four voting in its favour.

Mr. ANDREWS: Very well. I have my remedy.

The MAYOR proposed, and Mr. TATHAM seconded, the confirmation of the minute regarding the proposal to pay Mr. Humphrys £450 upon his retirement.

After some discussion as to the legal position of the Council in the matter, the proposal was rejected, as was also one in relation to his appointment as Assistant-Engineer at a salary of £150 per annum. The result is to leave the matter in an utterly unsatisfactory state; Mr. Humphrys' present position being worse than it was at first.

MANCHESTER CORPORATION GAS UNDERTAKING.

Annual Report.

We have received from the Superintendent of the City of Manchester Gas Department (Mr. F. A. Price) the report and accounts of the Gas Committee for the year ending March 31. The principal portions of the report, which bears the signature of Mr. William Kay, the Chairman of the Committee, are given below.

FINANCIAL.

The following is a summary of the items of income and expenditure; the figures for the previous year being given for comparison:—

Income.

1912.		1913.
£613,679	Gas, &c.	£621,806
106,661	Coke	139,509
39,388	Tar	52,505
44,600	Ammoniacal liquor and sulphate of ammonia	46,925
926	Sundry receipts	423
£805,254	Total	£861,168

Expenditure.

	Manufacture—	
£265,107	Coal, cannel, and oil	£264,463
107,596	Carbonizing wages, maintenance of plant, &c.	118,439
46,402	Renewals	21,915
	Distribution—	
63,196	Maintenance of plant, salaries and wages, &c.	58,554
36,608	Renewals	68,234
	Management—	
16,584	Salaries and wages	20,969
12,452	Other charges	12,955
62,038	Rents, rates, and taxes	63,987
£609,983	Total	£629,516
£195,271	Showing a gross profit for the year of	£231,652
44,111	From which has to be deducted the amount paid for interest on loans, &c.	41,005
£151,160	Leaving a net profit of	£190,647

The net profit has been appropriated as follows:—

1912.		1913.
£74,824	Sinking fund for redemption of loan debt.	£70,435
50,000	City fund in aid of rates	50,000
16,261	Applied in extension of works where borrowing powers are not granted	10,867
1,526	Premiums, &c., on purchase of 4 per cent. stock for cancellation	5,000
8,549	Reserve fund account	54,345
£151,160		£190,647
	Add discount (less brokerage, &c.) on 3½ per cent. stock placed to premium reserve account	465
		£191,112

The quantity of gas sold was 5,659,149,000 cubic feet—an increase of 4·35 per cent. on the previous year; and the average price realized was 2s. 2·31d. per 1000 cubic feet. The cost of coal, cannel, and oil per ton carbonized was 10s. 7·08d., against 10s. 8·04d. for the previous year; while the income from residual products rose to 9s. 6 82d. per ton, compared with 7s. 8·08d. per ton, representing a saving of 1s. 11·70d. per ton in the net cost of raw material, which, on the total carbonization of 499,440 tons, amounts to £49,320.

The amount transferred from revenue to the credit of the renewals account is £91,431, which, together with the interest on the fund, makes a total credit for the year of £95,729. The sum of £58,238 was expended during the year. The balance to the credit of the account is now £180,748.

The balance of the net profit appropriation account—*i.e.*, £54,345—has been transferred to the reserve fund, which stands at £68,898.

The expenditure on capital account during the year amounted to £25,847. Of this sum, £10,867 was provided out of net profits, and the balance out of loans. The total capital outlay at March 31, 1913, was £2,976,559, the loan debt in respect of which was £1,063,316. The balance of the sinking fund not actually applied to the redemption of debt at the same date was £6174.

Application was made to the Local Government Board on the 22nd of February for sanction to borrow £200,000 to provide additional capital for distribution plant. This sum it was estimated would meet the requirements of the Committee for the purpose stated for five years. Without holding a public inquiry, the Local Government Board authorized, in respect of this application, the borrowing of a sum (£103,000) sufficient to cover the capital expenditure on distribution plant for three years only; and the following sanctions have since been issued: £35,000 for mains and services, repayable in thirty years; £70,000 for meters, cookers, and fires, repayable in ten years.

PRICE OF GAS.

In accordance with the resolution of the Council of the 19th of February, the following scale of charges per 1000 cubic feet for gas was adopted, to come into operation as from March 25, 1913:—

Gas Consumed on One Premises per Quarter.	Within the City. s. d.	Without the City. s. d.
Ordinary consumers—		
Under 250,000 cubic feet	2 2	2 5
250,000 and under 1 million	2 1	2 4
1 million and upwards	2 0	2 3
Gas-engines—		
Under 1 million cubic feet.	1 9	2 0
1 million and under 2 millions	1 8	1 11
2 millions and upwards	1 7	1 10
[The preceding prices are subject to a discount of 2d. per 1000 cubic feet for payment within one month.]		
Public street lamps [net]	1 6	1 9
Automatic consumers—		
Cubic feet per penny [net]	37	33

Consequent upon the resolution of the Council of April 3, 1912, referred to in last year's report, the price for gas supplied to the public street lamps within the city was reduced to 1s. 6d. per 1000 cubic feet as from March 31, 1912—representing a concession to the city fund of £13,087 for the year. The present annual value of the concessions now made is estimated at £52,940 in the case of ordinary consumers, and at £8014 for automatic consumers, making the total concession to private consumers £60,954. In bringing the revised prices into operation, the system of discounts for early payment of accounts has been adopted, with a view to reducing the cost of collection in the future.

MANUFACTURE.

The quantity of coal carbonized, including the equivalents of oil, and gas made were as follows:—

	Material Carbonized. Tons.	Gas Made. Cubic Feet.	Make per Ton. Cubic Feet.
1913	499,440	5,944,838,000	11,903
1912	496,918	5,693,190,000	11,457

Owing to the continued improvement in carbonizing methods, the make of gas per ton is again higher; the increased production during the year being equivalent to a saving of 19,443 tons of coal. The illuminating power of the gas sent from the works, as tested by the "Metropolitan" No. 2 burner, was equivalent to 16·88 standard sperm candles.

DISTRIBUTION.

The total output of gas and the quantity unaccounted for, compared with the previous year, were as follows:—

	Gas Transmitted from Works. Cubic Feet.	Unaccounted for. Cubic Feet.	Percentage of Loss.
1913	5,941,395,000	192,359,000	3·24
1912	5,686,880,000	182,944,000	3·22

Increase in output, 4·48 per cent.

The continued development of the gas undertaking is shown by the increased number of consumers, and the additional cookers, gas-fires, and other appliances now in use.

The number of gas consumers on the 31st of March, compared with 1912, was as follows:—

	Within the City.	Without the City.	Total.
1913	174,070	11,225	185,295
1912	172,827	10,966	183,793
Increase	1,243	259	1,502

The number of automatic meters in use on March 31 was 68,129, or an increase of 1976; and the quantity of gas registered was 739,828,000 cubic feet—an increase of 81,275,000 cubic feet, or 12·34 per cent.

The number of gas-cookers owned and fixed by the Committee at the 31st of March was 65,731—an increase of 6932 on the previous year. The estimated consumption of gas by these cookers is 798 million cubic feet; being an increase of 61 millions, or 8·28 per cent., on the previous year's figures. There have also been fixed 33,261 grillers in connection with automatic and small ordinary meters. About 53 per cent. of the consumers now have the free use of a cooker or griller.

The number of gas-fires let out on hire on March 31 was 6731, showing the satisfactory increase of 4412. The consumption for the year is estimated at 70 million cubic feet. The total outlay on fires, amounting to £10,235, has been provided out of revenue.

On the 31st of March, the number of gas-engines in use was 1439,

compared with 1528 at the corresponding date the previous year. The quantity of gas used by these engines was 402,863,000 cubic feet—an increase of 12,628,000 cubic feet, or 3·24 per cent.

EXTENSION AND RENEWAL OF WORKS.

During the year, less work of a constructional character in the extension and renewal of plant was carried out than has been the case for some years.

Rochdale Road.—At this station, the construction of an installation of Glover-West vertical retorts, on the continuous working principle, of a capacity of 4 million cubic feet per day, was commenced; and though good progress is being made with the work, the plant will not be available for use before the end of the current year. When put into use, it will have a material effect in reducing the working costs of the station; there will also be an an entire absence of any nuisance arising from this system—a matter of great importance in this congested neighbourhood.

Bradford Road.—At these works, the new gasholder, of a capacity of 10 million cubic feet, has been put into use experimentally, and is working very satisfactorily. The increased storage capacity available will have the effect of reducing the works costs, and removing all anxiety as to the maintaining of the gas supply to the city during a prolonged fog. Workmen's dining-rooms and lavatories have been erected which will add to the comfort of the workmen. The system of breaking, screening, and washing coke introduced at this station has materially increased the revenue from coke; and it is advisable to consider the installation of similar plants at the other works of the department. The four remodelled sets of carburetted water-gas plant worked satisfactorily during the year; and the installation of the blast products purifying plant has removed any possible nuisance that might arise from the working of the plant.

Chemical Works.—The sulphuric acid and sulphate of ammonia plants are working satisfactorily, and giving excellent results in production and operating costs.

STREET MAINS AND LIGHTING DEPARTMENT.

The total length of mains laid to March 31, 1913, including high-pressure mains, was 965¾ miles and 82 yards; being an increase of 7½ miles and 413 yards during the year. The number of public lamps within the city is 20,990, and without the city 1360—a total of 22,350. The incandescent system of lighting has been applied to all the lamps within the city, and the number of burners fixed thereto is 27,494.

Many applications have been received for a supply of high-pressure gas for shop and warehouse illumination; and the Committee are extending the mains to meet this demand.

The Committee conclude their report with the statement that the works and plant generally (which are under the supervision of Mr. J. G. Newbigging, M.Inst.C.E., the Gas Engineer to the Corporation), have been maintained in the highest state of repair and efficiency.

GAS-WORKS RESIDUALS IN GERMANY.

We have received the report for the year 1912-13 of the Wirtschaftliche Vereinigung Deutscher Gaswerke, the German Syndicate for the sale of gas-works bye-products. The year just ended was the ninth of its existence. The annual general meeting was to be held yesterday in Cologne, the headquarters of the Syndicate, when the report was to be presented and general business transacted. Some extracts from the report should prove interesting, as showing the state of the residuals market in Germany.

It is stated that the effects of the coal strikes in the spring of 1912 made themselves felt right up to the spring of this year; and this, together with the shortage of goods trucks in the autumn of last year, caused an exceptionally large demand for coke. In fact, the demand greatly exceeded the contract amounts, but the supply held out fairly well, in spite of the fact of several large gas-works ceasing manufacture and taking their gas from coke-ovens in the Rhine and Westphalian districts. A slight rise in the price was necessitated by the all-round increases in coal prices. In the varying conditions of the market, the Syndicate was again enabled to do good service in steadying prices as much as possible. In the course of the year new branches were formed in Saxony-Thüringen, Bavaria, and one for South Germany in Mannheim; and, in order to foster the export trade of the gas-works on the north and east coast, a special branch commenced activity in Hamburg at the beginning of this year.

The coke sales for the year show the remarkable increase of over 50 per cent. more than in the previous year—being 609,712 metrical tons as against 401,282. The receipts for coke increased by about £220,755. The revenue from all bye-products was £776,098, or an increase of £324,235. The technical departments in Berlin and Cologne report a large increase in inquiries of all kinds, and the new branch for training technical men in the industrial uses of coke has received good support. A laboratory has been started in Cologne, for making the quick and reliable tests of coal, coke, ammonia, spent oxide, &c., which are often required. The quantity of coke offered for sale this year through the Syndicate is considerably less than last year, which is largely due to the general increase in local demand. The 375,267 tons announced by gas-works are already covered by forward contracts. Increases in coal prices were general; the English strike and rise in freights especially affecting English coal. Braun-coal briquettes proved more popular than ever, and are being used more and more by the industry itself for producer purposes. Tar prices were good, and remain good in the next year's contracts. Altogether 93,321 tons were sold for £125,525. Ammonia prices fell back somewhat, owing to two main causes—the small demand for agricultural purposes, and the growing activity in the synthetic ammonia industry. The 36,158 tons that were sold realized £114,295. Retort carbon, of which 1621 tons were sold, showed increased prices, as also

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spent oxide and cyanogen sludge, of which 10,356 tons passed through the Syndicate. Forward prices for these are also good. Advantage was taken by more gas-works of the purchase of pipes, fittings, &c., through the Syndicate. The number of members increased from 308 to 474, and negotiations are in progress with numerous others. Opposition has been encountered in several instances, owing to a misunderstanding as to the objects of the Society. It is by no means intended to be a trust for cornering residuals and raising prices, but rather to manage the sales of bye-products, and so avoid harmful competition among the producers.

NOTTINGHAM GAS EMPLOYEES' AGITATION.

With the men on strike still manifesting unyielding obduracy, there appeared little to warrant anticipations of a settlement when negotiations were re-opened at Nottingham in the early part of last week, in relation to the trouble which has had the effect for several months of crippling operations at the Corporation gas-meter repairing depôt, threatening also to bring within its course dislocation of work in other branches of the public service. After sixteen weeks of enforced idleness, due to their own precipitate procedure, it might have been thought that even the stormiest petrels of the trade unionist brood had had enough of warring with the official elements. But the grievance still appeared to be assiduously nursed behind the obviously clear desire of the Gas Committee to settle the dispute upon equitable and business lines, by fell designs on the rights of organized labour. The business had been dragging along with such persistent unprofitableness, that the Mayor's intervention within the past few days appeared to promise a solution of the difficulty. At considerable length, the matter was discussed at a private conference of the workmen, at which the Chief Magistrate presided, at the Exchange Hall. The practical suggestion was forthcoming from Mr. Ward that the whole case should be referred to arbitration; the proposal being, it is understood, that one who formerly occupied the highest official position in the City's service should be called in to adjudicate upon the conflicting contentions to which the controversy has given rise. But, from what transpired at a subsequent meeting of the operatives, it was evident that the proposal was viewed in no favourable light. Having struck as a protest against the retention in the shop of a non-union hand, the position was again made manifest that nothing short of the removal of the much-abused employee would satisfy the trade union requirements. That a further prolongation of the deadlock must inevitably follow from persistence in their irreconcilable attitude, appeared in no way to perturb the stalwarts, who remained secure in their reliance upon the financial assistance forthcoming from the National Amalgamation of Sheet Metal Workers. Their imagination appeared also to have been stimulated by the mental pictures drawn for their delectation, in which the Nottingham Gas Committee was depicted as having been reduced to a position of impotence through the inability to get repairing work done elsewhere.

There had been some tall talk indulged in all along of bringing out other sections of Corporation workers in sympathy with those on strike; but it has transpired within the last few days that some of the other trade unionists have not been quite so eager to jump into the breach. Several of those participating in the deputation which was met by the Mayor appeared to be not indisposed to press upon the meter repairers the reasonableness of submitting the case to arbitration; but the tinplate artificers proved stubborn in their opposition to accepting anything short of the terms of the ultimatum presented to the Committee, which, stripped of verbal veneer, meant an unconditional surrender to trade union dictation. There is evidence, however, that, while permitting the members of the Sheet Metal Workers' Amalgamation to "pay the piper," the Executive of the Nottingham Trade Council declare the right to some extent to "call the tune." Such appeared to be the attitude adopted at a meeting convened by the executive of that body on Wednesday, when representatives of the carpenters and joiners, wheelwrights, enginemen and firemen, builders' labourers, and others engaged in Corporation work were present; the understanding arrived at being that the matter should be further relegated for consideration to the various sections, whose delegates are to be called together to receive the reports during the present week. In the interval, however, the question of the further prolongation of the struggle obviously depended upon the decision of the meter repairers who were summoned to a special meeting last Friday evening.

The deliberations, which were then participated in by Mr. Gordon, made it clear that, as far as the tinsmiths are concerned, the case is to be one of war to the knife. The *impasse*, therefore, continues; and incidentally also the position illustrates the possibility of a rift within the trade union lute, inasmuch as the operatives connected with the National Amalgamation of Sheet Metal Workers appear to regard with considerable dissatisfaction the favourable attitude as to arbitration which other sections connected with the Trades Council have for the nonce taken up.

As an outward evidence of solidarity, however, the demonstration arranged for Sunday at Nottingham, in celebration of the 24th anniversary of the foundation of the National Union of Gas Workers, possessed some interest in regard to its general bearing upon the situation. The proceedings, at which Mr. J. R. Clynes, M.P., the President of the organization, and Mr. Will Thorne, M.P., the General Secretary, were the principal speakers, presented features of more than local significance by the attendance of the Secretaries from several of the chief Midland and North of England districts, as well as from the Scottish branch. The participants made their way in procession to a selected spot near the Victoria Embankment, the riverside boulevard which forms one of Nottingham's most attractive resorts. Plentiful harangues were forthcoming, in which appeals for concentration of labour interests were varied by characteristic gibing at existing conditions, under which capitalistic interests are supposed to have all the best of the bargain. The only direct reference to the tinplate workers'

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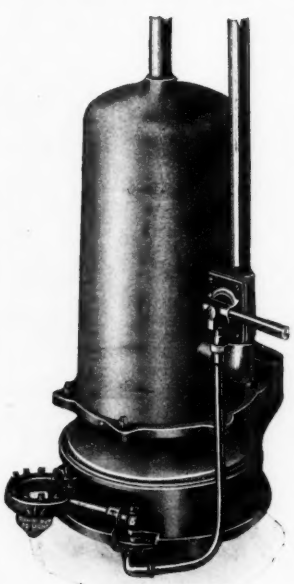

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dispute was that contained in the speech of the Chairman, Mr. Arthur Heyday, the District Secretary, who, prefacing his statement by the avowal that he was not there for the purpose of inflaming passion, declared that other branches of labour were, if necessary, prepared to take conjoint action in the matter.

Mr. Will Thorne, M.P., alluded to recent revolutions effected in regard to gas manufacture by the introduction of new carbonizing processes, and the consequent displacement of labour—enforcing the importance of the change, from the trade union point of view, by the statement that, as a result of inquiries in regard to operations at one of the largest works in London, he had found that by the new method of production there were 7½ million cubic feet of gas now made in 24 hours by 96 men working in three shifts of 32 men for eight hours each daily; the old method, by which only 5½ million cubic feet were produced daily, requiring the labour of 150 men in the same period—a difference of 54 hands. This increase in rapid methods of production, therefore, instead of being a blessing to the men, was, he contended, proving a curse—throwing many out of work who came into competition with others seeking employment. This question of machinery needed, he suggested, to be seriously tackled. Their forefathers, in the early part of the last century, attempted to meet a similar difficulty by destroying the new appliances. But that was not the policy to-day. Workers were not out to-day for destroying the new machinery, but for capturing and controlling it; and in this connection he urged the paramount consideration of insisting upon an eight-hour day.

The resolution submitted, commending the work done by the union in bringing about better economic and industrial conditions for the wage-earners of the country, appealing for new members, and, in view of "labour-saving machinery used for the purpose of reducing wages and increasing the profits of employers which should be used for the benefit of the whole community," urging upon the union to press forward the general Eight-Hour Day Bill, together with other reforms, was adopted.

BOLTON CORPORATION GAS UNDERTAKING.

Annual Report and Accounts.

We have received from the Gas Engineer and Manager of the Bolton Corporation (Mr. W. J. Smith) the report of the Gas and Lighting Committee, with the accounts of the Gas Department, as certified by the Borough Treasurer (Mr. Percy Farnworth), for the year ended the 31st of March last.

The report, which is signed by the Chairman of the Committee (Mr. W. Webster), shows that 97,191 tons of coal were carbonized, at an average cost of 12s. 3d. per ton, compared with 11s. 6¾d. for the preceding year. The make of gas was 1,089,486,000 cubic feet, or 11,209 cubic feet per ton, of which 10,759 cubic feet were accounted for. The Gas Street station was worked in the past year to its maximum capacity; half of the total make of gas being produced there. Full advantage was taken of the higher efficiency obtainable at these works as the result of the alterations carried out in the year 1910-11. The holder at the Lum Street works is being replaced by one of larger capacity on the spiral-guided principle. The Committee have decided to instal nine settings of vertical retorts on the Woodall-Duckham system, together with the necessary coal and coke handling plant; and the work is in hand. An increase of 5·36 per cent. in the quantity of gas made was accompanied by a decrease of £558 in the carbonizing wages and £71 in sundry wages, though a higher rate of pay was granted to the workmen. The quantity of gas sold and the sale per ton of coal carbonized are again record figures.

The report of the Borough Treasurer shows that the result of the year's working was a gross profit of £68,136. The interest and sinking fund charges (including the income-tax on profits) absorbed £28,664; leaving £39,472. Adding the credit balance from 1911-12 (£970), there was produced £40,442. Of this sum, £10,000 was taken for contributions to the depreciation and renewals fund, leaving a disposable surplus of £30,442. This was apportioned as follows: Additional contribution to the renewals fund, £5000; applied in aid of rates, £25,000; carried forward, £442.

MORECAMBE CORPORATION GAS UNDERTAKING.

Gas Profits and the Rates—Increase in the Manager's Salary.

The minutes presented by the Gas Committee of the Morecambe Corporation at the meeting of the Town Council last Tuesday included a recommendation that the salary of the Gas Engineer and Manager (Mr. C. R. Armitage) should be increased £10 per annum. In moving the adoption of the minutes and submitting the balance-sheet, Mr. A. W. Gorton, the Chairman of the Committee, said the Council had every reason to be thankful that the prosperity of the undertaking in 1909-10 had been continued. Prior to that year, they had a debit balance of £8491; but since that time they had contributed to the district rate £2072. Notwithstanding that they had a poor Easter last year, an increase of £525 in the cost of coal owing to the strike, and other matters to contend with, the gross profits amounted to £11,332, and the net profits to £2011. They proposed to transfer to the district fund £1200 of the profit, which he thought was very satisfactory considering all the circumstances, and the fact that last summer was not so good as the previous one. The Committee were rather proud of the way in which the gas undertaking had been made successful. Since the works became the property of the old District Council, they had paid £108,000 in principal and interest; and when they bore in mind how the department had been handicapped, it became a real pleasure to consider its present position. The cost of the manufacture of gas

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was 1s. 1d. per 1000 cubic feet, and they sold it at 3s. 9d., the difference going in interest and redemption, working expenses, and so forth. This compared very favourably with other municipal undertakings. In 1902, the capital was £2 8s. 11d. per 1000 cubic feet of gas sold; in 1911 it was £2 5s. 9d.; and last year it stood at £2 3s. 11d. It had consequently been reduced 5s. The quantity of gas made in 1902 was 74 million cubic feet; now it was 95 millions. The Committee decided to ask the Council, as a small recognition of the interest the Manager took in the concern and of his care and attention, to increase his salary by £10 a year. After some discussion, the minutes were passed, and the balance-sheet was referred to the Finance Committee.

DROITWICH GAS UNDERTAKING.

Report of the Engineer.

In his sixth annual report on the accounts of the Droitwich Corporation Gas Department, for the year ended March 31, the Engineer (Mr. F. Shewring) says that the gas manufactured during the year shows an increase of 1,777,300 cubic feet, or 7·7 per cent.; the gas sales increase being 2,047,000 cubic feet, or 10·8 per cent. more. This is the largest annual increase in gas sales since the Corporation took over the undertaking. The registration of gas by ordinary meters is 1,668,200 cubic feet more, and by prepayment meters 378,800 cubic feet more. The increased consumption of gas is in some measure due to the popularity of gas-fires, hot-water apparatus, and heating appliances; and every effort should be made to encourage this class of business. The gas sales have increased over 40 per cent. since 1908. The coal carbonized was 2234 tons, against 2081 tons. The yield of gas per ton of coal carbonized was 11,042 cubic feet, against 11,001 cubic feet. The gas sold and accounted for per ton of coal carbonized was 10,522 cubic feet, against 10,331 cubic feet; being an advance of 191 cubic feet on last year's record figure. Unaccounted-for gas has been further reduced from 6·07 per cent. to 4·66 per cent.; and this is the lowest figure yet recorded.

Notwithstanding the rise in the price of coal, the gross profit for the year, after allowing for depreciation, is £1397 13s. 8d., or an increase of £102 7s. 8d. Deducting repayment of principal (£358 7s. 2d.), interest on loans (£105 4s. 2d.), and additions to plant (£822 11s. 2d.), there is a credit balance of £111 11s. 2d.

Disposal of Redundant Bronze Coinage.—Notice has been given by the Deputy Master of the Mint to public companies and persons who, in the course of their business, may find themselves in possession of more bronze coin than they can readily dispose of, that assistance is rendered by the Mint in restoring the coin to circulation.

OSSETT CORPORATION GAS UNDERTAKING.

In the last number of the "JOURNAL" (p. 838), a few figures were given in regard to the working of the gas undertaking of the Ossett Corporation in the year ended March 31. Some additional particulars are furnished by the Gas Engineer and Manager (Mr. A. E. Mottram) in his annual report.

Owing to the defective condition of the station meter, the correct make of gas could not be given. It recorded 137,262,000 cubic feet, which the Manager estimated as about 4 million cubic feet too little. The gas sold was 131,186,500 cubic feet, or 9,406,700 cubic feet more than in the year ended March, 1912; showing a leakage of about 7 per cent. Of the total quantity of gas sold, 64,126,200 cubic feet was through ordinary and 32,789,800 cubic feet through prepayment meters, compared with 61,438,100 and 29,490,700 cubic feet respectively before. Gas-cookers consumed 10,506,700 cubic feet, against 8,978,100 cubic feet. The gross profit for the year was £7064; and the balance remaining, after paying interest and sinking fund charges, was £1020. The total cost of production and distribution was 2s. 5·18d. per 1000 cubic feet of gas sold; but this was reduced by the returns from residuals to 1s. 5·28d. Adding the capital charges, 11·06d., the figure is brought up to 2s. 4·34d. The amount received for gas was 2s. 6 21d. per 1000 cubic feet sold.

In moving the adoption of the Gas Committee's minutes at the last monthly meeting of the Council, the Mayor (Mr. H. Robinson), referring to the increased sale of gas to the extent of nearly 9½ million cubic feet, said it was 60·3 millions more than in the first year of Corporation management. If this proved anything, it proved that gas was still, and was likely to be, predominant for lighting and heating in the home and for the production of power in trade. The gas-works were gradually getting too small, especially the retort-house. The Committee had under consideration extensions which would result in economizing the working expenses; but this could only be done by a great outlay. The matter was not, however, ripe for discussion.

The minutes were passed.

IMPROVED STREET LIGHTING AT WANDSWORTH.

At a meeting of the Wandsworth Borough Council on Friday, the Lighting Committee reported that they had further considered the suggested improved lighting of the principal thoroughfares, and a report of the Borough Engineer on the subject. They recommended that inverted incandescent burners be substituted for all existing upright burners in these thoroughfares. The estimated additional cost for the first year was £126 17s. 7d., and for subsequent years £55 18s. 7d.

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per annum. The general question of improving the lighting of the streets in the borough would continue to receive attention.

Mr. Pickering said he was sorry the Committee had not thought fit to improve the lighting in such thoroughfares as Clapham High Street and Balham High Road. The time had arrived when they should improve the public lighting of the main business thoroughfares, instead of leaving it to shopkeepers to do, with the result that as soon as the shops were closed the streets were thrown into a state of gloom, which was not a credit to the borough. Alderman Lindsey said, of course, they were very grateful to the Committee for what they proposed to do; but he wished to go a little farther. He proposed that in all the principal thoroughfares double, instead of single, inverted burners be provided. When they realized the large sum received in rates from these highly assessed places, surely they deserved a little more consideration at the hands of the Council. Mr. Matthias thought it would be better, before the Council committed themselves to the expenditure involved in Alderman Lindsey's proposal, to have some idea of the extra cost. He maintained that they had in Wandsworth about the ugliest lamp standard that he had ever seen; and he asked the Committee to consider whether, as opportunity occurred, something more artistic could not be found and erected.

Eventually, after a long discussion, Alderman Lindsey withdrew his resolution; and the Council adopted the Committee's report.

SIR WILLIAM LEVER ON CO-PARTNERSHIP.

At the Institute of Directors last Tuesday, an address was delivered by Sir W. H. Lever, Bart., on "Co-Partnership and Business Management." In the course of it he made the following remarks.

The ordinary commercial relationship between employer and employed was the one system which had stood the test of time by means of wages. The employee was practically a debenture-holder in the business in which he was employed. This was a perfectly satisfactory basis of business; but it did not go far enough, as, with the keener competition, they ought to have an interest throughout the whole of their business. Every manufacturer had ideals of his own, and it took two to make a bargain; but his experience was that only one side got the benefit of the bargain. Competition kept them alert and strenuous in their business; but in the matter of fighting, as between capital and labour, their energies were wasted.

It was important that the employer should be a strict business man, and not a philanthropist; but it behoved capital to remember that any conflict between capital and labour was much better settled by an adjustment than by conflict. Labour rightly and properly demanded a greater share in the profits of industries; but it was only right that, in any agreement that might be made between employers and employed, no manufacturer should be handicapped by regulations which his competitors declined to recognize. The shareholders in the large aggregations of capital known to-day were no longer partners; they were simply investors or money-lenders—capital being entirely dependent upon management and labour. Wages were essential to service, and these wages should be at the rate current in the district in any co-partnership scheme that was put forward. But the workers must recognize that, though the article they produced might be of value to-day, in a week or two it might not be marketable, as its value was lost.

A discussion followed, after which a vote of thanks was accorded Sir William Lever for his address.

GASLIGHT AND COKE COMPANY'S ANNUAL SPORTS AND FLOWER SHOW.

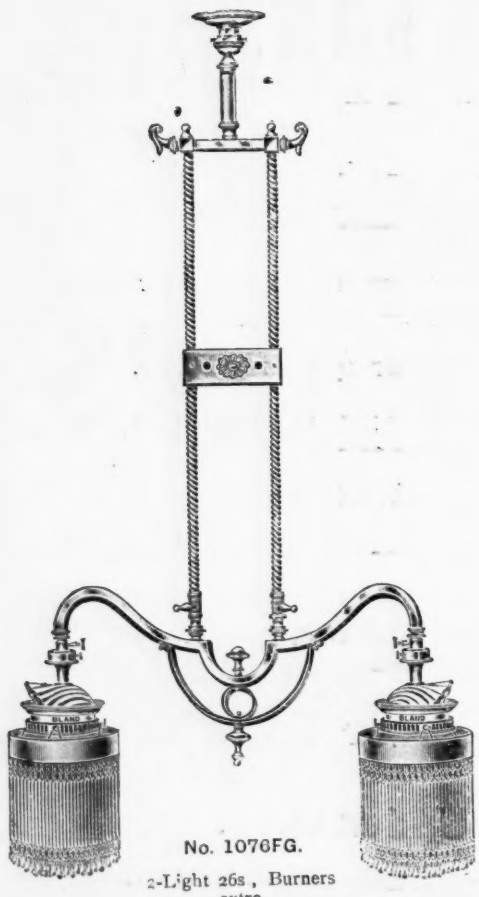
We have received from the Secretary of the Gaslight and Coke Company (Mr. H. Rayner) particulars of the sports and flower show which, as announced in the June issue of the "Co-Partners' Magazine," are to be held at the Crystal Palace next Saturday.

It appears from a circular bearing the signature of Mr. D. Milne Watson, the Company's General Manager, that, in response to a generally expressed wish on the part of the co-partners, the Directors kindly consented to hold a sports gathering for the employees, at the Crystal Palace, on the afternoon of the above-named day. On this occasion, the Directors propose to entertain to a sit-down tea one-third of the staff (including officers) who have been three years and upwards in the Company's service. The Directors have also extended their hospitality to the wives (actual or prospective) of those who will receive an invitation to tea. It is intended to hold these sports annually, and on each occasion to entertain one-third of the staff; consequently each member should be the guest of the Company once in every three years. The Directors have made arrangements with the Crystal Palace authorities and the Railway Companies by which each member of the staff can purchase a ticket, including admission to the Palace and return railway fare, for 1s. 3d. per head, or 2s. 6d. for himself and companion.

The sports will commence at three o'clock, and anyone in the Company's service will be entitled to compete, whether or not he has completed three years' service, and whether or not he is being entertained at tea by the Directors. Prizes will be presented at the close of the sports.

There will be held at two o'clock on the same afternoon as the sports a show of flowers, fruit, and vegetables grown by the co-partners, for which also prizes will be awarded. The show, which is under the management of a Committee of which Mr. D. Milne Watson is the Chairman, will be divided into two sections—the first open to all the Company's employees (including the staff officers); the second, only to those who have never won a prize at any flower show. In the first section, there will be classes of plants in pots, cut flowers, and vegetables and fruit; but in the second no fruit. The Judge will be Mr. Horace J. Wright.

THE BLAND LIGHT.



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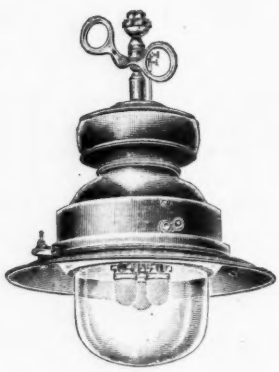
2-Light 26s., Burners extra.



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THE ALARM OF THE COAL MERCHANT.

The following is the advertisement of the British Commercial Gas Association in answer to the coal merchants' recent circular, which is referred to in a paragraph in another part of the "JOURNAL."

Seriously alarmed at the rapidity with which the modern efficient, convenient, labour-saving, dirt-avoiding, and hygienic gas-fire is displacing the old-fashioned crude coal fire, the Society of Coal Merchants have published a circular purporting to give "excellent reasons" for using coal and not gas.

The statements made therein are so inaccurate, and calculated to mislead those who have had no practical experience of modern gas-fires, and have not realized that gas-fires are used and highly commended by over 3000 medical men in London alone—some of whom have called our attention to the coal merchants' circular with comments the reverse of complimentary to it—that it appears advisable to warn the public against being influenced by this publication.

In subsequent issues of this paper we will give the evidence of eminent medical men and scientists to prove the baseless character of the coal merchants' attempt to check the rapidly progressing change from smoke-producing, air-defiling, work-creating methods of heating, cooking, and hot-water supply, to the modern system of burning the purified essence of coal (in gas-fires, gas-cookers, and gas water-heaters) which is steadily increasing the hours of sunshine in our cities as well as the health and leisure of the citizens, and is helping materially to solve the domestic servant problem.

SHEFFIELD CORPORATION WATER UNDERTAKING.

The Past Year's Working.

The annual report and financial statement in connection with the water undertaking of the Sheffield Corporation has been issued by Mr. William Terrey, the General Manager, who has forwarded a copy. It furnishes the following particulars.

The total income from all sources in the year ended the 25th of March last was £193,950—being an increase of £3579 on the preceding year; and the total expenditure amounted to £45.783, or £28 more than before. The gross profit totalled £148,167 (or £3551 more than the previous year), on which there were charges amounting to £141,022. This left a net profit of £7145—a decrease of £16,981. Deducting £18,506 set aside for the redemption of annuities and the extinction of loan indebtedness, the deficiency for the year was £11,361. The year's accounts include the payment of the Derwent Valley Water Board's precepts, amounting to £32,837, which is subject to readjustment and the return of any amount overpaid. The total capital expenditure at the close of the financial year was £3,615,925; and the accumulated surplus was £147,859.

The total population supplied on March 25 was 657,056; the number of houses, 113,717; of baths, 19,441; and the total domestic and trade supplies were 222,112—an increase of 4244. The average rate per head per day for domestic and all other supplies not by meter was 14·06 gallons; and the total average daily supply for all purposes was 29,403,380 gallons. The total for the year amounted to 10,732,233,367 gallons, compared with 10,811,318,782 gallons in 1911-12. The total length of mains is now 582 miles; the length of new mains laid during the year reaching 4 miles 1312 yards. The delivery of Sheffield's proportion of the first instalment of the Derwent Valley water commenced on the 8th of March last.

In introducing the minutes of the Water Committee at the meeting of the City Council last Wednesday, the Chairman (Alderman Styring) reviewed the working of the past year. He called attention to the large amount which was to be refunded by the Derwent Valley Water Board, and to the fact that, though the Corporation had had to pay, for the first time, a full year's contribution to the cost of the Derwent works and the Rivelin tunnel—a sum of £39,000, which had not yet produced a shilling of revenue—it would not be necessary to draw upon last year's unappropriated balance to the extent of more than £1300 or £1400. Speaking of the appointment of Mr. Colin Clegg as Resident Engineeer for the new Ewden Valley Works, he said they would all express their appreciation of the fact that there was, in the person of a son of Mr. J. C. Clegg, a gentleman who was qualified to undertake this work. But it was most important to understand that Mr. Colin Clegg was not appointed for this reason, but because he was the most suitable applicant the Committee had had before them. They recommended that Mr. Terrey should be appointed to carry out the administrative part of the work. He had had unique experience in work of this kind; and they were quite satisfied that the £250 a year which they proposed to pay him for his services would be money very well spent. Alderman Wardley moved, as an amendment, that the recommendation should be referred back, on the ground that the work came within the duties of the General Manager. After some discussion, however, the amendment was defeated by 34 votes to 16, with four members remaining neutral.

Reduction in Price at Llandudno.—The Llandudno Urban District Council, on the recommendation of the Gas Committee, have decided to reduce the price of gas to ordinary consumers by 2d. per 1000 cubic feet, and to slot meter consumers by 2½d. per 1000 feet. This is regarded as satisfactory, in view of the fact that the Council will have to pay at least 1s. per ton more for their coal than they did during the past year. As the amount of coal carbonized is about 8000 tons per annum, this increase in price will mean £400 extra on the cost of producing gas.

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GAS-WORKS PLANT OF EVERY DESCRIPTION.

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Duplex Purifier Valves,
Automatic Cover Fasteners,
Safety Discharge Shoots,
Rubber Jointing.

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London Office: 110, CANNON ST., E.C.

NOTES FROM SCOTLAND.

From Our Own Correspondents.

Saturday.

Edinburgh.—The Edinburgh and District Water Trust have approved of the minutes of the Works Committee regarding the afforestation of the Talla district, covering about 32 acres. This is to cost about £670.

Glasgow.—The 700,000 tons of coal required by the Corporation Gas Department has been secured at an average advance of 1s. 8d. per ton over last year's figure, which, it may be remarked, was 2s. 2d. more than was paid in the preceding year.

The Water Committee have decided to recommend the Town Council to increase the domestic water-rate, within the limits of compulsory supply, from 4½d. to 6d. per £1 of rental.

The annual examination of the Talla Water-Works has just been concluded, when several of the Glasgow councillors, including the Lord Provost, accompanied their Edinburgh brethren.

Following upon the Smoke Abatement Exhibition held last year, where so many forms of gas heating and other domestic apparatus were shown, the Corporation are now arranging an electrical exhibition, where heating and cooking devices, vacuum cleaners, and a large variety of electrically operated domestic apparatus will be on view. The exhibition is to open the last week in October, and remain open during the first weeks of November.

Aberdeen.—The Water Committee have decided to adopt the 10 million gallons per day scheme for the city, but have deferred deciding whether the source of supply should be the Rivers Dee, Avon, or Dye. They agreed, however, that the treatment with lime of the existing supply from the Dee should be proceeded with, at an estimated cost of £28,000.

Arbroath.—Notwithstanding a considerable increase in the cost of coal, the price of gas is to remain unchanged. Mr. G. R. Wallace, the Convener of the Gas Committee, in making this announcement to the Town Council, mentioned that the report of the Gas Manager, Mr. A. Young, for the past year was of a highly satisfactory nature. The gross balance for the year was about £5400, out of which £1400 was paid for sinking fund, and other sums for interest and annuities, &c.; leaving a net balance of £1364 to be carried forward.

Cupar.—What has been headed in the local papers as "a gas explosion" has occurred at a linen factory, where a suction gas engine of 160 H.P. was at work. The exhaust gases from this engine, having served to heat water, passed into an exhaust silencer, and thence into a chimney. Evidently some unburnt gas had passed to the base of the chimney and there become ignited, causing an explosion, which rocked the chimney. The high wind prevailing at the time completed the rocking, and the top of the chimney fell.

Dundee.—The water accounts show a small deficit; the revenue being £164 short of the estimate, which amounted to £64,289. A sum of £15,255 has been spent on capital expenditure, and the county rates have increased £200.

Dunfermline.—The Gas Committee have decided to retain the present prices for gas in the burgh, despite the increased cost of coal, but recommend a reduction in the price charged to the villages of Limekilns and Charlestown from 4s. to 3s. 9d. per 1000 cubic feet. The increased cost of the coal will mean about £5000 additional expenditure over last year; while the wages bill is also £500 to £600 up. Residuals are estimated to increase the revenue by about £2000.

Falkirk.—The Town Council have been having a lively discussion about the conditions at the gas-works. It was suggested by some of the councillors that the recent explosion had been the cause of the sinking of the bench, by others that the bench had only recently taken to sinking, and by still a further section that it had been sinking from the first. It appears from the remarks of the Provost that the late Mr. William M'Crae, who designed the works, suggested that heavier foundations should be put in; but these suggestions were ignored. The present vexed question is as to whether a further pit should be sunk in the retort-house near the bench, whether an expert should be called in to advise the Council, or whether underpinning should be at once proceeded with. The ultimate finding was that a pit should be sunk in the retort-house; but there appears to be some doubt if this will be a safe proceeding. Surely, if ever there was a case for the expert this is one, for undoubtedly the strata at these works are very treacherous, and call for the most careful treatment.

Galashiels.—The Tenants' Defence Association have drawn attention to the working of the Galashiels Gas Company at a public meeting of the ratepayers called to protest against a manifesto issued by the Town Council, in which they propose to hand over the installation of an electric supply scheme to a company, to be promoted locally for the purpose. They state that the Gas Company do not make it their aim to supply the cheapest gas, but so adjust their prices that they may be enabled to pay a dividend of 10 per cent.

Greenock.—The Sub-Committee on Vertical Retorts have submitted their report, in which it is stated that they have decided in favour of an installation of verticals. They estimated that by the new system a yield of 15 per cent. upon the capital outlay will be obtained. Bailie Taylor moved that the proposal should be approved, and that the offer of Messrs. Woodall and Duckham be accepted. The contemplated expenditure for 32 retorts is £33,403, of which they have a sum of £12,851 in hand. They therefore propose to apply for the sanction of the Secretary of Scotland for borrowing powers up to £50,000. There is also a proposal on hand for a new gasholder; but this was delayed. Bailie Mitchell proposed, as an amendment, that 48 retorts on the Klonne system should be added to the present retort-bench. He pointed out that in 1910 it had been estimated that to put the gas-works in a state of efficiency would cost £37,710, but that with the present proposals it would be more likely to be £85,000. This proposal was seconded by Mr. Dunn; but the amendment only received three votes, against 18 in favour of vertical retorts.

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Hamilton.—The question of the illuminating power of the gas has been exercising the minds of the people in the burgh. The recent test published showed that the candle power was being reduced considerably below that which was customary a very short while back. In consequence of complaints received, a better quality has been supplied for the past month, the average of which has been 16·63-candle power. The Manager, Mr. Ballantyne, has again called attention to the fact that rich gas is now unnecessary in view of the extended use of incandescent mantles.

Kirkintilloch.—The report of the Gas Manager for the past year shows an increase of 4,250,000 cubic feet in the quantity of gas supplied, bringing up the total to 75,000,000 cubic feet. In regard to coal, 7793 tons have been used, which is about 900 tons increase over the previous year. The price paid for the coals is 10s. 5d., or 1s. 3d. more; while the quantity of gas produced per ton has dropped from 9974 cubic feet last year to 9383 cubic feet this year. Increased profits to the extent of over £1000 have been received from residual products.

Lanark.—As a result of the negotiations which have been going on for some time between the Town Council and the Lanark Gas Consumers' Company, Limited, with regard to the purchase of the gas-works by the Corporation, a meeting of the shareholders of the Company has been held at which it was agreed to accept the offer of the Town Council of £16,000 for the purchase of the works, plant, &c. A further meeting of the shareholders will be held to confirm this decision.

Lanarkshire.—The Middle Ward District Committee of the County Council of Lanarkshire have engaged Mr. Henry O'Connor to report on the desirability of several districts for the supply of gas by the county itself.

Perth.—Mr. Peter Rollo, slot-meter collector, who has had six years' service with the Corporation, has been the recipient of a handsome suit case on his leaving to fill a similar position with the Aldershot Gas, Water, and District Lighting Company. The presentation was made on behalf of the office staff by Mr. Lindsay, the Treasurer.

Redding.—The Eastern District Committee of the County Council of Stirling have agreed to authorize the supply and erection of a lighting plant, so that the ratepayers in the district will have the benefit of public lighting.

Stirling.—It will be remembered that the Gaslight Company thought it advisable to give early intimation that, with the increased cost of coal, it would be necessary for them to raise the price of gas from 2s. 6d. to 2s. 8d. per 1000 cubic feet. The Directors have now had a draft report of the Company placed before them; and after a careful examination of it, they have decided to withdraw the former announcement, and to continue the charge at 2s. 6d. per 1000 cubic feet.

Troon.—A deputation has been received by the Town Council as to the installation of an electric light system into the town, in view of the fact that an extension of the gas-works will be necessary in the near future. The suggestion was that a cable might be laid from Kilmarnock or Ayr, and the employment of an expert to report upon the scheme was suggested. The deputation undertook to pay the cost of such an opinion. Comparisons were made with Kilmarnock; but the difference in the size of the two places will have to be very carefully considered, or the good folk of Troon will find that they have saddled themselves with a very expensive white elephant. The Town Council are to take the matter into consideration.

Wishaw.—The Gas Committee have unanimous'y resolved to recommend that the price of gas within the burgh and in the Netherton district for all purposes other than power and general trade purposes be reduced by 2d. and 3d. per 1000 cubic feet respectively, as from and after the date of next survey.

CURRENT SALES OF GAS PRODUCTS.

LIVERPOOL, *June* 21.

Sulphate of Ammonia.

The market has been somewhat irregular, but on the whole prices have been fairly well maintained, the closing quotations being £12 16s. 3d. per ton f.o.b. Hull, £12 17s. 6d. to £12 18s. 9d. per ton f.o.b. Liverpool, and £13 per ton f.o.b. Leith. Direct business has been scarce, but there has been good demand for covering June contracts, and the market has had to depend in the main upon this There has been less doing in the forward position, the premium required being above the ideas of buyers, but £13 10s. per ton is reported to have been paid, f.o b. good ports, for January-June, 1914, delivery. The near months have been done at but a small premium on spot prices.

Nitrate of Soda.

The market for this article is unchanged, and the values on spot remain at 10s. 7½d. per cwt. for ordinary, and 10s. 9d. for refined quality.

LONDON, *June* 23.

Tar Products.

Business has again been quiet in the markets for tar products during the past week, and there is no material alteration in prices. Pitch continues quiet; and although there are few inquiries, consumers will not pay the prices being asked at the present moment. One or two orders have been accepted for next season's shipment at very reasonable figures. Ninety per cent. benzol remains firm, and fair prices are being paid, though some Continental selling has been going on at figures lower than those quoted from this side. Solvent naphtha is very quiet; and new contracts are difficult to arrange. Crude carbolic does not excite much interest at the moment. Consumers are unwilling to contract at to-day's prices. Creosote keeps fairly firm, although some contracts are reported to have been arranged for forward delivery at slightly lower figures.

The average values during the week were: Tar, 25s. 6d. to 29s. 6d. Pitch, London, 41s. 6d. to 42s. 6d.; east coast, 41s. 6d. to 42s. 6d.;

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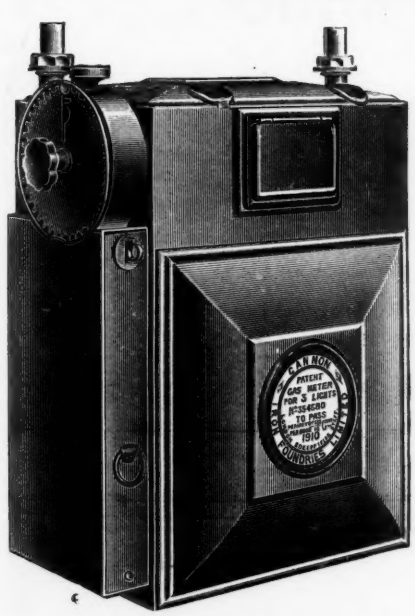

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west coast, Manchester, 40s. 6d. to 41s. 6d.; Liverpool, 41s. 6d. to 42s. 6d.; Clyde, 41s. 6d. to 42s. 6d. Benzol, 90 per cent., naked, London, 1s. 0½d. to 1s. 1d.; North, 1s. to 1s. 0½d.; 50-90 per cent., naked, London, 10d. to 10½d.; North, 10d. Toluol, naked, London, 11d. to 11¼d.; North, 10⅞d. to 11d. Crude naphtha, in bulk, London, 5¼d. to 5⅜d.; North, 4⅞d. to 5¼d. Solvent naphtha, naked, London, 11d. to 11½d.; North, 9d. to 9½d. f.o.b. Heavy naphtha, naked, London, 11½d. to 1s. f.o.b.; North, 10d. to 10½d. f.o.b. Creosote, in bulk, London, 3½d. to 3¼d.; North, 2⅝d. to 3d. Heavy oils, in bulk, 3⅛d. to 3⅜d. Carbolic acid, casks included, 60 per cent., prompt, east and west coasts, 1s. 3¼d. to 1s. 4d. Naphthalene, £5 to £9; salts, 50s. to 55s., bags included. Anthracene, "A" quality, 1½d. to 1⅝d. per unit, packages included and delivered.

Sulphate of Ammonia.

There is little fresh to report in this article. Foreign orders are scarce, and there appears to be plenty of tender stuff coming on to the market to meet existing orders. Outside London makes are quoted at £12 6s. 3d.; Hull, £12 16s. 3d.; Liverpool, £12 17s. 6d.; Leith, £12 18s. 9d. to £13; Middlesbrough, £12 16s. 3d. to £12 17s. 6d.

COAL TRADE REPORTS.

Northern Coal Trade.

There is still quietness in the coal trade of the North. The lack of ready steamers has checked exports; and now the great race holidays at Newcastle are influencing the local output. In the steam coal trade, best Northumbrians are from 14s. 9d. to 15s. per ton f.o.b.; second-class steams from 13s. to 13s. 3d.; and steam smalls vary from 7s. 9d. to 9s. 6d., according to quality. In the gas coal trade, the consumption is low; but users are increasing their stocks, and there are a number of small contracts in course of arrangement. Best Durham gas coals are quoted at 14s. 6d. to 14s. 9d. per ton f.o.b. for prompt delivery. Second-class are from 13s. 9d. to 14s.; and "Wear specials" about 14s. 6d. to 15s. per ton f.o.b. Tenders are now under consideration for gas coal for Darlington; but the figures have not yet transpired. As current prices are now about 1s. 3d. per ton above those of a year ago, some advance must be expected; but at the same time, buyers are not as eager as they were to place forward contracts. But it is worth notice that the consumption of Durham coal is still at a very high rate. Coke is generally quiet. The limited production of gas coke steadies its price at 17s. 10d. to 18s. per ton f.o.b.

Scotch Coal Trade.

Throughout the whole of the Scotch coal trade a much quieter tone prevails, and values are receding. On Friday, on the Glasgow Coal Exchange, the following were the approximate prices quoted: Steam coal, 12s. 9d. to 13s. 3d.; splint, 14s. to 14s. 6d.; ell, 12s. 6d. to 13s.; trebles and doubles, 12s. 6d. to 13s.; and singles, 12s. to 12s. 6d., f.o.b. Glasgow.

Progress of the Primitiva Gas Company.

A special correspondent of the "Daily Chronicle" traced, in an article which appeared last Saturday, the progress of the Primitiva Gas Company of Buenos Ayres, Limited. Views of two spiral-guided gasholders—one of a million cubic feet capacity, erected in 1908, and the other of 4½ million cubic feet capacity, erected last year—are given, as well as a view of the interior of one of the works. The writer shows, as the columns of the "JOURNAL" have done from time to time, that the present Company has been formed by the amalgamation of five separate Gas Companies; but he remarks that, considering the city of Buenos Ayres is some 15 miles square, and has a population of about 1,300,000, this is not to be wondered at. The authorized capital of the Company to-day is £5,800,000, and the plant consists of three gas and one chemical works within the city, which, when combined, cover an area of more than 30 acres of land. In addition to this, they have some 14 branch offices, and the administration office in the centre. There are 14 gasholders of various dimensions throughout the districts, and 1065½ miles of mains, varying from 3 to 36 inches diameter.

Padiham Gas Supply.

The Gas Engineer and Manager of the Padiham Urban District Council (Mr. A. J. Harrison) reports that the past year's working of the gas undertaking was the most successful on record, as notwithstanding that coal cost an average of 1s. 9d. per ton more than in the preceding year, amounting to £662, and though the outlay for new meters and cookers allotted to revenue account totalled £357, the net profits increased by £371. There was practically no extension of the town during the year, yet the consumption of gas increased by upwards of 4 million cubic feet, equal to 4·8 per cent., principally through prepayment meters—showing a greater use of gas by the artisan class. During the seven years Mr. Harrison has been at Padiham, the consumption has increased by 30 million cubic feet, equal to about 55 per cent. The total quantity of gas made last year was 84,181,000 cubic feet—an increase of 2,268,000 cubic feet; and the unaccounted-for gas was 1,328,019 cubic feet, or 1·58 per cent. The gross receipts from residuals were equal to 84·7 per cent. on the cost of coal; whereas in March, 1905, they realized only 50 per cent. The income and expenditure on revenue account last year were £17,903 and £11,146 respectively; leaving a gross profit of £6757 (an increase of £422) and a net profit, including a small amount of dividend on Consols, of £1721. The gross profit equals 1s. 7⅛d., and the net profit 5d., per 1000 cubic feet of gas sold, and 9·5d. in the pound on the district rate.

The Company which is proposing to supply coke-oven gas to the Brussels Municipality, as noticed in the "JOURNAL" last week, is the Société des Fours à Coke of Vilvorde, which was formed in October last under the auspices of the Société des Forges de Clabecq.

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briefly describes our small Cooker, which is specially suitable for small dwellings. It is highly finished and embodies all the advantages of the large cooker.

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The PARKINSON STOVE CO., Ltd.,
BIRMINGHAM & LONDON.

Investment of Compensation Money in Gas Shares.

At the Bow County Court, on Monday last week, before His Honour Judge Smyly, K.C., George Rowland applied for the payment out of Court of £175 awarded him under the Workmen's Compensation Act for the loss of a leg by accident. As the lad was under age, he was asked what he wanted the money for; and the father said he proposed to buy his son some clothes, and then put the balance in the profit-sharing scheme of the South Metropolitan Gas Company, by whom he was employed, which yielded 5½ per cent. His Honour said he knew there was such a scheme; but it seemed a rather startling suggestion that compensation money should be invested in gas shares. The father said it was certainly a very safe investment, and he knew of nothing better that could be done with the money. His Honour said he had never before been asked to let an infant have his money out to invest in a gas company; and he was afraid he could not do it now, much as he believed the scheme to be a good one. It was a very rare thing for the Court to lose its hold on money before the person was of age. He must therefore refuse this application.

Sale of Stocks and Shares.

A good opportunity was afforded at the Mart, Tokenhouse Yard, last Tuesday, for investors in gas and water undertakings to increase their holdings; the sale conducted by Messrs. A. & W. Richards including three new issues of capital by order of Directors. The first lots offered consisted of £10 "B" shares in the Grays and Tilbury Gas Company, ranking for a dividend of 7 per cent., but carrying £5 19s. per cent. as from the 1st prox. They were sold at the rate of £11 to £11 2s. 6d. per share. Next came an issue of additional ordinary £10 shares in the Lowestoft Water and Gas Company, ranking for 7 per cent., but similar shares receiving 5¼ per cent. They fetched from par to £10 5s. each. Some 4 per cent. perpetual debenture stock of the same Company realized from £94 to £95 per £100. A small parcel of 4½ per cent. perpetual debenture stock of the Annfield Plain and District Gas Company fetched £90 per £100. The remaining lots consisted of stocks and shares offered for sale by order of executors. Some 4½ per cent. consolidated first mortgage debenture stock of the Cape Town and District Gas Company, Limited, fetched £75 per £100 of stock; the purchaser taking the interest accruing from Jan. 1 last, amounting to 2¼ per cent. A few £5 fully-paid preference shares in the Primitiva Gas Company of Buenos Ayres, Limited, fetched £4 15s. apiece; the purchaser taking the dividend of 2s. 6d. per share accruing from the beginning of the year. Some £5 ordinary shares in the Company, the dividends on which for the past three years have been at the rate of 8 per cent. per annum, were sold for £5 15s. each, *cum div.* A parcel of £1 shares in the South Barracas (Buenos Ayres) Gas and Coke Company, Limited, carrying 4 per cent. dividend, fetched 12s. 6d. each. Some £5 shares in the Bombay Gas Company, Limited, on which dividends at the rate of 7½ per cent. per annum have been paid for the past two years, were sold at £6 5s. to £6 10s. each. The final lots consisted of ordinary stock of the Oriental Gas Company, Limited, on which 8 per cent. per annum, free of income tax, has been paid for several years; and it realized from £124 to £125 per £100.

East Surrey Water Company.—At the annual general meeting of this Company held last Friday, the Directors reported that the profit for the year ended the 25th of March was £28,037. Adding the balance brought forward made a total of £36,237. Interim dividends, &c., had been paid to the amount of £15,888, and £1000 had been placed to the credit of the contingency fund—leaving £19,349. Final dividends, making 5, 10, and 7 per cent. per annum, on the preference "A" and "B" shares, were declared; and a balance of £9777 was carried forward. There were nearly 300 additional consumers last year; and 4¼ miles of new mains were laid.

APPLICATIONS FOR LETTERS PATENT.

13,397.—Brettell, F. G., "Gas-engines." A communication from C. H. Joy. June 10.
13,440.—Edgeworth, K. E., "Gas-producers." June 10.
13,452.—Francks, A. H., "Gas-lighting apparatus." June 10.
13,456-7.—Daniel, P., "Gas-engines." June 10.
13,459.—Wünsche, E., "Photometers." June 10.
13,498.—International Air-Gas Corporation, Ltd., and M'Lagan, R., "Burners for use with air-gas." June 11.
13,518.—Gohmann, A., "Retort-furnaces." June 11.
13,556.—Radet, L., "Automatic light extinguisher." June 11.
13,557.—Parker, J., and A. G. Sutherland, Ltd., "Mercurial gas-governor." June 11.
13,583.—Tooth, L. F., "Gas-burners." June 12.
13,603-4-5.—Berlin-Anhaltische Maschinenbau Akt.-Ges., "Burner operating mechanism." June 12.
13,606.—Webb, W. H., Brettell, W. G., and Adamson, A. J., "Gas-compressors." June 12.
13,608.—Constantinescu, G., "Obtaining combustible gas." June 12.
13,615.—Grimshaw, S. G., "Artificial fuel." June 12.
13,724.—Burkheiser, K., "Process for removing sulphuretted hydrogen from gases." June 13.
13,727.—Renouf, E. de F., "Igniting gas-lamps." June 13.
13,737.—Jolly, J. B., "Gas-producers." June 13.
13,738.—South Metropolitan Gas Company and Chandler, D., "Burners for gas-fires." June 13.
13,757.—Allott, A. D., "Bunsen burners." June 13.
13,769.—Parslew, E. J., "Operating gas-burners." June 14.
13,792.—Farnham, R. V., "Gas-producers." June 14.
13,813.—Fiddes, W. J., "Gas washer or scrubber." June 14.
13,829.—Valentine, H. S., "Gas-heating stoves." June 14.

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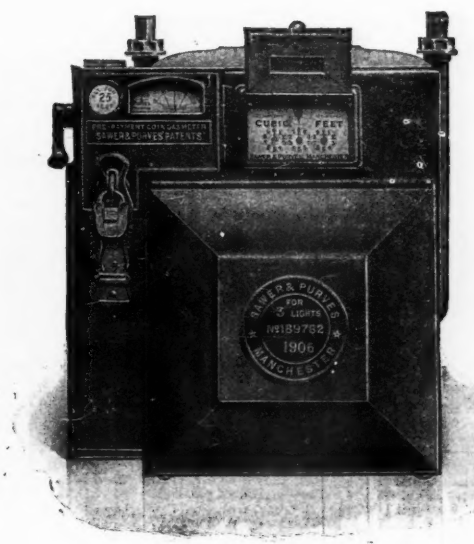

MILES PLATTING, RADFORD ROAD,

MANCHESTER & NOTTINGHAM.

Agent for Scotland:

JNO. D. GIBSON, 2, CAUSEYSIDE STREET, PAISLEY.

Wages Advanced at the Maryport Gas-Works.—The stokers at the Maryport Gas-Works having applied for an increase in their wages, the Gas Committee resolved, and the Council have approved, that, on and after the 1st prox., the wages shall be as follows: Leading stokers, 6s. per shift; other stokers, 5s. 6d. per shift; foreman gas-fitter, 6s. per day; yardmen, 5s per day, including service till four o'clock on Saturday afternoon. This represents an all-round advance of 6d. per shift or per day.

The Old Story.—At the last meeting of the Lewisham Board of Guardians, the Works Committee reported that Mr. Allbright, who is supervising the installation of the electric light at the workhouse and infirmary, has reported that certain "extras" for the infirmary contract were required, and the Committee approved of these. The Committee, however, seem to have exercised some care in not informing the public as to the nature of the extras, nor the amount of outlay that they represent.

Brighton Corporation and the Gas Company.—At the meeting of the Brighton Town Council last Thursday, it transpired that the letter from Alderman Carden, suggesting that the Lighting Committee should take steps to purchase the Brighton and Hove Gas Company's undertaking, had been again submitted to the General Purposes Committee, but they had resolved that they did not deem it advisable to entertain the proposal. Mr. Tindall suggested to the Lighting Committee that the Borough Accountant should be instructed to ascertain what sums during the past year or two had been charged by the Gas Company to revenue which should have been charged to capital account; but after hearing a report by the Town Clerk on the subject, they resolved to inform Mr. Tindall that they regret that they are unable to recommend the Council to adopt the suggestion that he made.

Bramshott Water Supply.—A definite scheme for a water supply to the parish of Bramshott, in Hampshire, has at length been decided upon. As the Parish Council had been unable to settle the matter, it was referred to the Rural District Council at Petersfield, and two meetings were occupied in debating three schemes. One was a very favourable offer by the Wey Valley Water Company; the second was an offer to furnish, on equitable terms, a full supply from the springs at Wagner Wells; and the third consisted of plans by Messrs. Taylor and Wellin, of Newcastle-on-Tyne, to discover an independent source. This found most favour, and was really the only one proposed, though the parish representative from Bramshott strongly urged a further reference back to the Bramshott ratepayers. The Newcastle plan was eventually adopted by 7 votes to 2; and the Local Government Board are to be asked for leave to borrow the requisite money.

Water-Works Extensions at Wath.—The Wath-upon-Dearne Urban District Council having applied for sanction to borrow £12,000 for the purpose of extending the water-works, a Local Government Board inquiry was held into the application last Tuesday. The Surveyor (Mr. J. H. Drew) explained that the Council supply water to the inhabitants of the urban district of Wath and portions of two adjacent parishes. The estimated cost of the scheme was £11,963. The Clerk (Mr. P. C. Muspratt) informed the Inspector that the Council desired the period of repayment to be as long as possible. The requirements of the district had increased considerably, and the proposed extensions were needed. The Medical Officer of Health (Dr. F. J. Burman) said there had been serious complaints in the higher parts of the district in regard to the scarcity of water, principally in the forenoon. The scarcity was increased in the summer of 1912 by the Council, at his request, cutting off the supply from the Hadber reservoir, which consisted of water drawn from the surface of a field which was liable to contamination.

GAS COMPANIES' STOCK AND SHARE LIST.

Despite a praiseworthy disposition at the beginning of last week to look on the bright (least dark, perhaps, would be the truer expression) side of things, the Stock Exchange has gone through a very gloomy and dispiriting period, and, what is more, the outlook at the close was about at its worst. Depressing factors, which were bad enough the week before, had none of them improved, and some were rather worse. The attitude of the Balkan States is distinctly more threatening, the enforced liquidation still continues, Continental demands for gold have tightened the situation, and buyers are becoming shy even of very tempting prices. Prices, accordingly, fell steadily almost day by day. The tone of moderate cheerfulness noted at the opening on Monday rather died down before the close. Business was very quiet; and two small failures were announced. Government issues shaped easier, but Consols did not move. Home Rails received some support, and Americans improved. Tuesday brought a great falling off—said to be due largely to pressure from abroad. Liquidation, which was hoped to be nearly at an end, broke out again. The money outlook helped Consols down ¼. Rails were weak all round; Americans were depressed; and the Foreign Market was dull. Wednesday was a little lighter; the pressure to sell being somewhat relieved. Business was, however, very inactive. Consols were steady, and Rails had a few advances here and there. Americans improved; but Foreign were poor. Weakness prevailed on Thursday. Continental movements were adverse; and the markets in general receded. Consols were ⅛ lower, and prices in all departments were easier. Friday was quite disheartening, with dull and drooping markets unable to stand up against the pressure to sell. Government issues gave way, and Consols fell another ⅛. Prices of Rails showed a further loss, Americans did the same, and the Foreign Market was timid. Saturday was a most depressing day; and markets all round were in a wretched state. Consols touched 72 11/16, and closed at 72⅝ to 72¾—a fall of ⅛ in the day and ½ in the week. In the Money Market, there was a light demand for short loans; but discount rates hardened steadily. Business in the Gas Market was about a fair average in volume, taken all round, but unevenly distributed; the bulk of it being in two or three undertakings. Movements were most meagre; there being only two changes of quotation in the London market, one up and the other down. In Gaslight and Coke issues, the ordinary was fairly busy at unchanged prices—transactions ranging from par to 101¾. In the secured issues, the maximum changed hands at 78¾, the preference was quite active at 95 to 96 (a fall of ½), and the debenture marked 72½. South Metropolitan was quiet and unchanged at 108½ to 109½; and the debenture was done at 73¾. In Commercials, the 4 per cent. realized 106 to 107, and the debenture 70¼. Among the Suburban and Provincial group, Alliance and Dublin was dealt in at 72, British at 45½, and South Suburban at 117¼ to 118½. On the local Exchange, Liverpool "A" marked 209½, ditto "B" 151 (a fall of 1), and ditto debenture 98½. In the Continental companies, Imperial changed hands at 164, Union at 80⅛, European at 17⅜ to 17 15/16, and Malta at 4¾ and 4 13/16. Among the undertakings of the remoter world, Bombay made 6¼, Buenos Ayres debenture 92, Primitiva 5¾ to 6, and ditto preference 4 37/38 to 5.

Issue.	Share.	When ex-Dividend.	Dividend or Dividend & Bonus.	NAME.	Closing Prices.	Rise or Fall in Wk.	Yield upon Investment.
£			p.c.				£ s. d.
1,551,868	Stk.	April 11	5	Alliance & Dublin Ord.	70—73	..	6 17 0
374,000	,,	Jan. 16	4	Do. 4 p.c. Deb.	84—87	..	4 12 0
280,000	5	April 11	7½	Bombay, Ltd.	6¼—6⅝	..	5 11 1
50,000	10	Feb. 27	15	Bourne-mouth Gas and Water } 10 p.c. B 7 p.c. Pref. 6 p.c.	28½—29½	..	5 1 8
332,000	10	,,	7		15½—16	..	4 7 6
75,000	10	,,	6		13¾—14¼	..	4 4 3
580,000	Stk.	Feb. 27	14	Brentford Consolidated	260—265	..	5 5 8
330,000	,,	,,	11	Do. New	200—205	..	5 7 4
50,000	,,	,,	5	Do. 5 p.c. Pref.	113—115	..	4 6 11
206,250	,,	June 13	4	Do. 4 p.c. Deb.	92—94*	..	4 5 1
217,380	Stk.	Feb. 27	11	Brighton & Hove Orig.	206—211	..	5 4 3
244,200	,,	,,	8	Do. A Ord. Stk.	151—154	..	5 3 11
530,000	20	Mar. 28	12½	British	45—46	..	5 8 8
120,000	Stk.	Dec. 30	4	Do. 4 p.c. Deb. Stk.	89—91	..	4 7 11
245,771	Stk.	,,	4	Buenos Ayres 4 p.c. Deb.	91½—93½	..	4 5 7
100,000	10	—	—	Cape Town & Dis., Ltd.	2—3	..	—
150,000	10	—	—	Do. 4½ p.c. Pref.	4—5	..	—
100,000	Stk.	Dec. 30	4½	Do. 4½ p.c. Deb. Stk.	78—83	..	5 8 5
157,150	Stk.	Feb. 13	5	Chester 5 p.c. Ord.	109½—111½	..	4 9 8
1,513,280	Stk.	Feb. 27	5/9/4	Commercial 4 p.c. Stk.	105—107	..	5 2 1
560,000	,,	,,	5⅛	Do. 3½ p.c. do.	102—104	..	5 2 6
475,000	,,	June 13	3	Do. 3 p.c. Deb. Stk.	69—71*	..	4 4 6
800,000	Stk.	,,	4	Continental Union, Ltd.	80—83*	..	4 16 5
200,000	,,	,,	7	Do. 7 p.c. Pref.	125—129*	..	5 8 6
492,270	Stk.	—	5¼	Derby Con. Stk.	124—125	..	4 12 0
55,000	,,	—	4	Do. Deb. Stk.	103—105	..	3 16 2
1,002,180	10	Jan. 16	10	European, Ltd.	17⅜—18½	..	5 8 1
16,415,840	Stk.	Feb. 13	4/17/4	Gaslight and Coke } 4 p.c. Ord. 3½ p.c. max. 4 p.c. Con. Pref. 3 p.c. Con. Deb.	160—162	..	4 15 6
2,600,000	,,	,,	3½		77—80	..	4 7 6
4,062,235	,,	,,	4		94—96	−½	4 3 4
4,674,850	,,	June 13	3		71½—73½*	..	4 1 8
258,740	Stk.	Mar. 13	5	Hastings & St. L. 3½ p.c.	89—91	..	5 9 11
82,500	,,	,,	6½	Do. do. 5 p.c.	—	..	—
70,000	10	April 25	11	Hongkong & China, Ltd.	17—17½	..	6 5 9
131,000	Stk.	Mar. 13	7⅛	Ilford A and C	152—155	..	4 18 4
65,780	,,	,,	6½	Do. B	120—122	..	5 0 5
65,500	,,	Dec. 30	4	Do. 4 p.c. Deb.	89—91	..	4 7 11
4,940,060	Stk.	May 16	9	Imperial Continental	160—165	..	5 9 1
1,335,000	Stk.	Feb. 13	3½	Do. 3½ p.c. Deb. Red.	85—87	..	4 0 6
300,942	Stk.	Mar. 13	6	Lea Bridge Ord. 5 p.c.	120—123	..	4 17 7
561,000	Stk.	Feb. 27	10	Liverpool United A	208½—210½	..	4 15 0
718,100	,,	,,	7	Do. B	150—152	−1	4 12 1
306,083	,,	Dec. 20	4	Do. Deb. Stk.	98—100	..	4 0 0
63,480	Stk.	Jan. 16	3	Maidstone 3 p.c. Deb.	68—70	..	4 5 9
75,000	5	June 13	6	Malta & Mediterranean	4⅝—4⅞*	..	6 3 1
250,000	100	April 1	4½	Met. of Melbourne } 4½ p.c. Deb.	98—100	..	4 10 0
541,920	20	May 30	4	Monte Video, Ltd.	12½—13	..	6 3 1
1,775,892	Stk.	Feb. 27	4½	Newc'tle&G'tesh'd Con.	98⅝—99½	+½	4 10 6
529,705	Stk.	Dec. 30	3½	Do. 3½ p.c. Deb.	85—86	..	4 1 5
55,940	10	Feb. 27	7/7/0	North Middlesex 7 p.c.	13—14	..	5 4 7
300,000	Stk.	May 16	8	Oriental, Ltd.	124—129	..	6 4 0
60,000	5	Mar. 28	10	Ottoman, Ltd.	8—8½	..	5 17 8
60,000	50	Feb. 27	13	Portsea, Island B	125—128	..	5 1 7
100,000	50	,,	12	Do. C	122—125	..	4 16 0
249,980	5	May 16	8	Primitiva Ord.	5¾—6¼	..	6 8 0
499,960	5	Dec. 30	5	,, 5 p.c. Pref.	4¾—5	..	5 0 0
521,600	100	June 2	4	,, 4 p.c. Deb.	93—95	..	4 4 3
346,198	Stk.	Dec. 30	4	River Plate 4 p.c. Deb.	92—94	..	4 5 1
275,000	5	Apl. 11	12	San Paulo, Ltd.	—	..	—
150,000	10	,,	6	Do. 6 p.c. Pref.	11½—11⅝	..	5 2 2
125,000	50	Jan. 2	5	Do. 5 p.c. Deb.	49—51	..	4 18 0
135,000	Stk.	Mar. 13	10	Sheffield A	225—227	..	4 8 1
209,984	,,	,,	10	Do. B	225—227	..	4 8 1
523,500	,,	,,	10	Do. C	225—227	..	4 8 1
90,000	10	May 30	7½	South African	9½—10½	..	7 2 10
6,429,895	Stk.	Feb. 13	5/9/4	South Met., 4 p.c. Ord.	108—110	..	4 19 4
1,895,445	,,	Jan. 16	3	Do. 3 p.c. Deb.	73—75	..	4 0 0
209,820	Stk.	Feb. 27	8½	South Shields Con. Stk.	161—163	..	5 4 4
952,795	Stk.	Feb. 27	6	S'th Suburb'n Ord. 5 p.c.	117—119	..	5 0 10
60,000	,,	,,	5	Do. 5 p.c. Pref.	115—117	..	4 5 6
117,058	,,	Dec. 30	5	Do. 5 p.c. Deb. Stk.	117—119	..	4 4 0
694,740	Stk.	May 16	5	Southampton Ord.	101—104	+1	4 16 2
120,000	Stk.	Feb. 13	7½	Tottenham and } A 5 p.c. B 3½ p.c.	139—142	..	5 2 1
483,940	,,	,,	5⅝		115—117	..	4 18 3
149,470	,,	Dec. 30	4	Edmonton } 4 p.c. Deb.	92—94	..	4 5 1
182,380	10	,,	5	Tuscan, Ltd.	5—6	..	8 6 8
149,900	10	Jan. 2	5	Do. 5 p.c. Deb. Red.	96½—98½	..	5 1 6
236,476	Stk.	Feb. 27	5	Tynemouth, 5 p.c. max.	114—115	..	4 6 11
255,636	Stk.	Mar. 13	6⅞	Wands-worth } B 3½ p.c. 3 p.c. Deb. Stk.	137—140	..	4 18 2
88,416	,,	Dec. 30	3		63—70	..	4 5 9

Prices marked * are "Ex-Div."

Price of Gas at Droitwich.—At the meeting of the Fire and Lighting Committee of the Droitwich Corporation on Monday last week, the Chairman (Alderman Gabb) submitted the annual financial statement, and recommended a further reduction from 2s. 10d. to 2s. 9d. per 1000 cubic feet in the price charged for gas to ordinary consumers, and 2s. 6d. per lamp to the Council for street lighting. He pointed out that in the last four years the price of gas had been reduced by 6d. per 1000 cubic feet, and that the change proposed would mean a total of 7d., which was a great boon to the burgesses. No reduction was recommended to consumers of gas through slot-meters, as the expense incurred in fittings recently was quite equal to the 1d. reduction to ordinary consumers. The statement was adopted.

Lincolnshire Village Water Supplies.—The Sleaford Rural District Council on Monday last week received analyses of water taken from wells in various parts of Kirkby Laythorpe, all of which were pronounced unfit for drinking purposes. It was resolved that a scheme should be prepared for supplying Kirkby and Asgarby, as the residents declined to join in the scheme for supplying Evedon, Ewerby, Haverholme, and Anwick, the bore for which has already reached a depth of 80 feet. The Council sanctioned a scheme for supplying East Heckington with water at a cost of £2760, and resolved to apply to the Local Government Board for a loan of this amount. Other applications for water were received from North Kyme, South Kyme, and Praie Grounds, hundreds of residents having at present to obtain their drinking water from polluted sources.

Sudbury Water-Works Improvements.—The Sudbury Town Council had a special meeting last Tuesday to consider a scheme prepared by Mr. Percy Griffith, M.Inst.C.E., for the improvement of the water-works, the pumping plant at which has become old-fashioned and costly in working. According to Mr. Griffith's report, it was estimated that they would save approximately £140 a year in fuel, £25 a year in repairs, and £5 a year in oils—a total of £170. If they borrowed for the purpose of the scheme the sum of £1200, which Mr. Griffith estimated it would cost, and the annual repayments were £104, they would have a net saving of £66 a year, or the equivalent of nearly a penny rate. At the end of fifteen years they would have paid off the loan of £1200, and then they would be saving approximately £170 a year, or (say) a rate of 2d. in the pound. It was resolved that the Water-Works Committee should be empowered, if they thought fit, to employ Mr. Griffith as Consulting Engineer on the scheme, and to apply to the Local Government Board for authority to raise £1200 to carry it out.

Filtration of Morley Water.—Mr. H. R. Hooper, M.Inst.C.E., recently held an inquiry at the Town Hall, Morley, with respect to an application made by the Corporation to the Local Government Board for power to borrow £10,000 for the provision of mechanical filters at the Withens Clough reservoir, near Mytholmroyd. The Town Clerk (Mr. Fred Thackery) stated that the gathering-ground was moorland, and the water in the Withens reservoir was at certain times of the year very turbid, and that light, peaty matter settled in the main and distributing pipes; the water drawn from the taps of the consumers being often very much discoloured. In 1901, the Corporation purchased mechanical filters, which were erected at Morley, but were now quite inadequate; the three filters only being able to deal with about 600,000 gallons a day. The Council were therefore compelled to provide additional filter plant. It was proposed to erect eleven mechanical filters capable of dealing with 88,000 gallons per hour, and 2,112,000 gallons per day. Under an agreement with the Halifax Corporation, Morley was entitled to draw up to 100 million gallons per annum. But the quantity never exceeded 500,000 per day; and it was proposed that the existing filters at Morley should be reserved to deal with the Halifax water.

Atherstone Water Supply—Under the advice of Professor Lapworth, the Atherstone District Council, who are in need of an additional water supply, have been having borings made for water at Warton, about four miles from the town. The operations have been conducted in consultation with Dr. Lapworth, son of the Professor, who in his report says that the difficulty in the district is to find good water-bearing rocks. With certain exceptions, there is no source but the Bunter rocks; and it is somewhat remarkable that these have never before been made use of, because they are the finest water-bearing rocks in the kingdom. In this particular district, they cover an area of about a square mile. Dr. Lapworth had anticipated that from this area there would be a yield of from 100,000 to 200,000 gallons a day. Recent records, however, show a yield of 10,000 gallons an hour, or 240,000 gallons a day; and though the pumping has been continuous, the water-level in the well has not been lowered. The Council are recommended to construct a reservoir and provide mains for the parts of the district concerned.

The Halesworth Gas Company, Limited, has been registered with a capital of £3000, in £1 shares.

Messrs. Anderson and Son, Limited, has been registered with a capital of £25,000, in £1 shares, to carry on the business of colliery proprietors, coke and bye-products manufacturers, makers of gas and patent fuel, iron-masters, and steel makers and converters.

We have received from the British Graetzin Light, Limited, of Chapter Street, Westminster, a series of leaflets giving particulars of their new patterns of burners. They comprise a workshop burner, to be used with mantle protector only; the "Baby" burner, suitable for box-rooms, lavatories, &c.; the "Secunda" burner, in globes and also with glass bead fringe; and the "Triumph" and "Graetzin" high-power burners for low-pressure gas, for which a high duty is claimed.

The Directors of the James Keith and Blackman Company in their report state that the amount of business done during the past twelve months exceeded that of any previous year. After providing for debenture interest, and making allowance for depreciation and reserves against doubtful debts, the accounts show a net profit of £22,624; and this sum, with the balance brought forward, makes a total of £25,056. A dividend on the ordinary shares at the rate of 10 per cent. per annum, tax free, absorbs £6801, the sum of £9000 is transferred to the reserve account, and £3550 is carried forward.

The gross profit for the year ended April 30, 1913, of Messrs. Head, Wrightson, and Co., Limited, is £36,620, which is brought up to £38,896 by the addition of the balance of undivided profits. The Directors propose that this sum shall be applied as follows: Interest on debentures, £6750; dividend on preference shares to March 31, £9302; reserved for ditto from March 31 to April 30, £845; reserve account for general purposes, £2000; reserve account for workmen's compensation, £1000; depreciation, £5000; writing-off expenditure on purchase and development of patents, £2000; dividend at the rate of 4 per cent. on the ordinary shares, free of income-tax, £8400; balance to be carried forward, £2598.

A newspaper which has just reached us from South Africa furnishes evidence that the Manager of the South African Lighting Association, Limited (Mr. William Arnott), is entering with renewed vigour upon his campaign on behalf of gas. He organized a series of cookery demonstrations in the Loubser Hall, Port Elizabeth, on the 26th ult. and four following nights, to be given by Miss H. Royal-Dawson, one of the Visiting Teachers of Cookery under the Port Elizabeth School Board. On the closing evening, there was a competition by young men in preparing a breakfast, consisting of fried eggs and bacon and toasted bread—a prize being given to the most expert. The electric lighting being very bad, Mr. Arnott put a gas-pendant over the stage.

WANTED, FOR SALE, CONTRACTS, &c., ADVERTISEMENTS IN THIS WEEK'S "JOURNAL."

Appointments, &c., Vacant.

ACCOUNTANT. 5321, Partington's, Victoria Embankment, W.C.
GAS ENGINEER AND MANAGER. Workington Corporation. Applications by July 14.
RETORT SETTERS. Nechells Gas Works, Birmingham.
STOKER. Shaftesbury Gas Works.
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